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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 42915, 43012, 43022, 43035, 43342, 43382, 43473, and 43605.

42868 (ANL-7331) SPECTROGRAPHIC ANALYSIS OF BISMUTH-TIN EUTECTIC ALLOYS BY SPARK-IGNITED, LOW-VOLTAGE AC-ARC EXCITATION. Huff, E. A.; Kulpa, S. J. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 12p. Dep. CFSTI.

The spark-ignited, low-voltage ac-arc discharge was used as an excitation source for the spectrographic determination of chromium, iron, manganese, and nickel in bismuth-tin eutectic alloys. These impurities could be determined over a concentration range of a few ppM to 1%. Samples were dissolved, and cobalt was added to serve as an internal standard. Both copper and silver rods were used as supporting electrodes. Excellent sensitivity with good accuracy and precision could be realized. The applicability of this procedure to the quantitative analysis of other matrices is also discussed. (auth)

42869 (EUR-3210.f(Vol.2)) CONDITIONS OPTIMALES DE FONCTIONNEMENT DU GENERATEUR DE NEUTRONS. Rapport Annuel Avril 1965-Avril 1966. (Optimum Operating Conditions for the Neutron Generator. Annual Report, April 1965-April 1966). Vernin, E.; Perdijon, J. (Societe Anonyme de Machines Electrostatiques, Grenoble (France)). Apr. 17, 1967. Contract 024-64-4 IRAF. 96p. (In French). Dep.

Possibilities offered for analysis with an installation for activation analysis were investigated. A catalog of those spectra obtained both with fast neutrons and thermal neutrons was made up, where irradiation and counting conditions were exactly defined and where the standards containing 200 mg of the element to be examined were employed. From this, a table of sensitivities was calculated covering 47 elements chosen from those most frequently encountered. Afterwards the installation was used for analyzing samples sent by industrial companies or laboratories. The results showed that a certain number of specific analytical problems can easily be solved through activation analysis using an accelerator. Advantage was taken of the experience acquired in the use of tritium targets to carry out a statistical investigation into the behavior of 22 targets of varying origins. (auth)

42870 (EUR-3558.e) FEASIBILITY OF USING A URANIUM HOLLOW CATHODE LAMP AS PRIMARY SOURCE IN ATOMIC ABSORPTION SPECTROSCOPY. Rossi, G.; Omenetto, N. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Aug. 1967. 12p. Dep.

The feasibility of a U hollow-cathode lamp, working at high-discharge current, as primary source in atomic absorption spectroscopy is presented. The extreme complexity of the U spectrum makes possible the coincidence of its lines with the analytical resonance lines of most of the elements. Uranium was excited in a Ni hollow cathode at 500 mA discharge current. The advantages of this multi-line source are stressed. First results are presented for the elements Cu, Mg, Mn, Fe, Ni, Cr, and In. (auth)

42871 (IDO-17253) DEPENDENCE OF SPECIFIC REACTIVITY MEASUREMENTS ON THE MOLECULAR STRUCTURE OF VARIOUS ORGANIC COMPOUNDS. Gustafson, Ruth Peereboom (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 1967. Contract AT(10-1)-205. 56p. Dep. CFSTI.

A research program was undertaken to determine if a difference in crystal or molecular structure could be detected as a change in reactivity of a reactor specially designed to detect such changes. The materials studied were graphite (irradiated and unirradiated), benzene, toluene, the halogenated derivatives of toluene, the xylene isomers, 1-methylnaphthalene, some ethyl halides, mesitylene, cyclohexane, n-hexane, and n-heptane. The reactors in which the reactivity measurements were made were the Reactivity Measurement Facility (RMF) and the Advanced Reactivity Measurement Facilities I and II (ARMF-I and -II) located at the National Reactor Testing Station, Idaho. Reactivity effects due to crystal or molecular structure can probably be observed, particularly in high-energy neutron flux measurement positions in the RMF and the ARMF-II. A linear relation exists between the specific reactivity worth of a hydrocarbon molecule and the number of hydrogen atoms in that molecule. Deviations from linearity can be interpreted as reactivity effects due to binding effects in the compounds. The halogenated derivatives of toluene deviated from this linear relation because of neutron absorption effects, but specific reactivity differences between geometrical isomers can be attributed to binding effects within the molecule without regard to absorption effects. The discovery of this linear relation permitted the reactivity worth in the RMF or ARMF-II of any hydrocarbon to be predicted quite accurately. Alternatively, the number of hydrogen atoms present in an unknown hydrocarbon could be determined from a reactivity measurement. (auth)

42872 (IS-T-172) DIRECT AND INDIRECT DETERMINATION OF OLEFINIC UNSATURATION WITH BROMINE. Wood, Garth Eugene (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 73p. Dep. CFSTI.

Thesis.

The determination of olefinic unsaturation by direct titration with bromine was accomplished by titrating with a standard solution of bromine in glacial acetic acid and locating the end point spectrophotometrically. The solvent system was a mixture consisting of 85% acetic acid-10% water-5% carbon tetrachloride by volume, and titrations were performed both with and without employing mercury(II) chloride as a catalyst to accelerate the rate of addition of bromine to the double bond. It was found that compounds possessing isolated double bonds readily added bromine without the aid of the mercury(II) chloride catalyst. Also, if no catalyst was used, compounds possessing a strong electron-withdrawing substituent allylic to the double bond or possessing a carbonyl group conjugated with the double bond failed to add bromine within the time required for determination of a compound possessing an isolated olefinic linkage. This allowed determination of the reactive components of mixtures of these two types of compounds. In the presence of a mercury(II) chloride catalyst no selective determination by bromination was possible because the unreactive unsaturates slowly added bromine thus interfering with the determination of the more reactive component. A point-slope technique for the location of end points in spectrophotometric titrations was developed. Small amounts of unsaturation were determined by an indirect spectrophotometric method. (P.C.H.)

42873 (IS-T-190) ACTIVATION ANALYSIS FOR TRACE QUANTITIES OF IODINE IN BIOLOGICAL MATERIALS. Hahn, Paul Balser (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 43p. Dep. CFSTI.

Thesis.

A destructive neutron activation procedure, which is accurate, simple, and sensitive, was developed for determination of trace

quantities of iodine in a wide variety of biological materials. The method employs a sodium peroxide bomb fusion technique for post-irradiation decomposition of the sample and solvent extraction for isolation of iodine activity. Both beta and gamma counting techniques can be employed for detection of the induced iodine activity. The method was shown to be precise and accurate to within ±2 to 3% and free from systematic errors and interfering nuclear reactions. In the absence of interfering nuclear reactions the practical sensitivity of the analysis approaches 1 ppB. Although no interference was encountered from the production of iodine radionuclides on fission of ^{235}U, the interference was considered a possible limitation in the sensitivity and accuracy of the analysis. The magnitude of the uranium interference was estimated and a technique for its reduction was proposed. The proposed method was found as accurate and as sensitive as previously reported methods for trace iodine analysis in biological materials by activation analysis with the advantage of avoiding a distillation technique commonly employed in these methods. (auth)

42874 (IS-T-196) USE OF METASTABLE STATES IN ACTIVATION ANALYSIS. Menapace, Laurene Mary (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 37p. Dep. CFSTI.

Thesis.

A method is described for determination of cadmium and mercury in the presence of each other using the metastable state of the isomer produced on activation with epithermal neutrons. Standard samples were determined both with and without cadmium-lined rabbits; the latter technique may enhance one activity and minimize the other so as to give a more accurate quantitative analysis. Cadmium lined rabbits also minimize the potential interference from radionuclides produced by thermal-neutron activation. By use of enriched isotopic samples the ratio of the (n,γ) to the (n,n′) reaction for production of the metastable state was determined. This was accomplished by comparing the activities of a sample in which, in one case, the activity is coming from the (n,γ) and the (n,n′) reactions, and in the other case, virtually all activity is from the (n,n′) reaction. (auth)

42875 (SC-DR-67-696) MOISTURE CONTENT DETERMINATION IN RIGID POLYURETHANE FOAMS. Thacker, C. C. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 23p. Dep. CFSTI.

Data are presented to show that serious errors occur when the heat/vacuum method is used to determine the moisture content of rigid polyurethane foam. An instrument that eliminates these errors and provides a simple, accurate, and rapid means of determining water content is discussed. Results are derived from the data to show that no water is present in carefully processed rigid foam. (auth)

42876 ACTIVATION ANALYSIS OF POTASSIUM AND SODIUM, AND THEIR BEHAVIOUR ON CATION EXCHANGE RESIN. Baptista, J. L.; Grade, M. R. S. (Comissao de Estudos de Energy Nuclear, Lisbon). pp 424-8 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Experiments are described for the determination of small quantities of Na and K by radioactivation, followed by the use of a weak ion exchange resin in the carboxylic acid form for reparation purposes. Samples of 0.1 mg of solid Na and K oxalates were irradiated in a thermal neutron flux of $10^{12}/cm^2/sec$. Cylindrical resin beds of Amberlite IRC-50 in polyethylene columns were used for the separation. Electronic equipment continuously measured the radioactivity from the columns. Samples passed through the columns were prepared by mixing amounts of Na and K in proportions 4:1 and 2:1 respectively in the range 10^{-5} g. For each experiment a pair of columns was used under similar conditions, only distinguished by the use of ^{42}K or ^{24}Na as tracer. On elution with HCl (pH 2.18 to 2.50) there was rapid isolation of alkali metals by a small volume of eluant, but a high hydrogen affinity to the weak group of the resin caused Na and K to elute very quickly. Oxalic acid eluant gave similar results to those with HCl of pH 2.18. With acetic acid (0.13 to 0.06M) there was a slight displacement of the K peak in relation to that of Na, and after a few minutes Na was obtained free of K. With ammonium oxalate peaks were narrower than with the other solutions, and some separation occurred at pH 9.5. (UK)

42877 GROUP TYPE ANALYSIS OF CARBOXYLIC ACIDS FORMED BY DEGRADATION OF i-DODECANE AND KEROSENE WITH NITRIC ACID. Ohwada, Ken (Japan Atomic Energy Research Inst., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 427-30(Aug. 1967).

Quantitative analysis for carboxylic acids formed by diluent degradation with nitric acid was investigated by group type analysis. Based on Beer-Lambert's law and alkaline titration, the apparent molar extinction coefficient (E^{C}_{max}) for C = 0 stretching vibration ($\bar{\nu}_{C=O}$: 1,694 cm^{-1}) of carboxylic acids in degraded diluents was determined to be 620 ± 20 $mole^{-1} \cdot l \cdot cm^{-1}$. Using this value, the concentrations of carboxylic acids formed under various nitric acid concentrations, temperatures, and contact times were determined, and some of the results were compared with the measured data from alkaline titration. The method might also be used to determine the concentration of carboxylic acids hydrogen-bonded with tri-n-butyl phosphate (TBP) in degraded solvent. (auth)

42878 DETERMINATION OF SOME TRACE CONTAMINANTS IN HIGH PURITY GALLIUM AND GALLIUM ARSENIDE BY NEUTRON ACTIVATION ANALYSIS. Bujdoso, Erno; Miskei, Mihaly; Ormos, Gyorgy (Metal Industries Research Inst., Budapest). Kohasz. Lapok, No. 5, 236-40(1967). (In Hungarian).

Determination of the trace contaminants silver, cobalt, iron, indium, and zinc in high-purity gallium and gallium arsenide by activation analysis is reported. Separation of the elements was carried out by extraction, ion-exchange chromatography, and distillation. The method of separation and the results are described. (JPRS)

42879 ACTIVATION-ANALYSIS DETERMINATION OF IMPURITIES IN SILICOCHLOROFORM. Rausch, H.; Csada, G. I.; Szabo, E. (Forschungsinstitut fuer Fernmeldewesen, Budapest. Zentralforschungsinstitut fuer Physik, Budapest). Chem. Zvesti, 21: 592-601(1967). (In German).

For determination of the trace impurities Cu, Sb, Cr, Au, As, Hg, and P in trichlorosilane neutron activation analysis, gamma spectrochemical methods, and chemical separation were used. The trace impurities were bound in complexes with triphenylchloromethane, the sample evaporated to dryness, and irradiated in solid form (1.5×10^{13} N cm^{-2} s^{-1}). Since the chlorine content interfered with determination of phosphorus, parallel activation was carried out using a cadmium filter. (tr-auth)

42880 GENERAL SPECTROGRAPHIC TECHNIQUE FOR THE DETERMINATION OF VOLATILE TRACE ELEMENTS IN SILICATES. Tennant, W. C. (Dept. of Scientific and Industrial Research, Wellington, New Zealand). Appl. Spectrosc., 21: 282-5(Sept.-Oct. 1967).

Details are given of a quantitative dc-arc method for determination of up to 15 volatile elements in trace amounts in silicates. Twenty milligrams of sample were mixed with an equal weight of an alumina–lime buffer containing 0.1% bismuth trioxide as internal standard and the mixture arced as the anode in a graphite cup. Careful control of arcing conditions allowed the determination of common volatile elements in amounts down to 1 ppM and in the case of several rare elements, notably Ag, Au, In, and Tl, down to 0.1 ppM. (auth)

42881 PLASMA-ARC STUDIES FOR ALLOY ANALYSIS. Muntz, James H. (Air Force Materials Lab., Wright–Patterson AFB, Ohio). Appl. Spectrosc., 21: 300-4(Sept.-Oct. 1967).

An evaluation of the plasma-arc spectrochemical technique for alloy analysis was made. Matrix effects were studied and found to be present at all concentrations investigated, but were not significant enough to preclude the use of one set of standards for any one particular base metal. The application of the technique for the analysis of aluminum, iron, nickel, and possibly cobalt-base alloys was demonstrated using identical operating conditions and with only three sets of standards. Tungsten was determined with a graphite cap covering the plasma's tungsten transfer electrode to prevent spectral lines from this source. The maintenance required by the nebulizer is the main disadvantage of the technique. (auth)

42882 QUANTITATIVE DETERMINATION OF IMPURITIES IN SOLIDS BY MASS SPECTROMETRY. Elliott, R. M.; Swift, P. (Associated Electrical Industries Ltd., Manchester, Eng.). Appl. Spectrosc., 21: 312-14(Sept.-Oct. 1967).

The reliability of quantitative impurity analysis of solids by spark-source mass spectrometry was improved as a result of recent investigations. Previously the technique was highly successful for quantitative estimation of extremely low impurity levels and for direct comparison of impurity levels in two similar materials. However, improvements in reproducibility and the establishment of reliable relative-sensitivity factors were required for accurate determination of absolute concentrations. It was shown that the ion accelerating voltage and the level of rf spark excitation can have marked effects on relative sensitivity factors. It is, therefore, extremely important to maintain these parameters constant. The influence of sample inhomogeneity on reproducibility was investigated, and here the very low sample consumption of the rf spark can be a disadvantage. The alterna-

tive method of excitation by low-voltage dc arc can be less affected by inhomogeneity because a larger amount of sample is involved in an analysis. Following the improvements in reliability of relative-sensitivity measurements, more systematic determinations of these factors were carried out. It is shown that, when these correction factors are applied, quantitative accuracy of the order of 10% is achieved. (auth)

42883 THE DETERMINATION OF COPPER AND BISMUTH IN HIGH-PURITY LEAD METAL BY NEUTRON ACTIVATION ANALYSIS. Op De Beeck, J.; Hoste, J. (Ghent Univ.). Acta Chim. Acad. Sci. Hung., 53: 137-43(1967).

The determination of copper and bismuth in lead in the presence of Hg, Au, Sb, Cd, and Tl impurities requires destructive separation following neutron activation. The internal electrolysis technique was shown to be the most suitable method for this purpose. (auth)

42884 ISOTOPIC ANALYSIS OF RARE GASES WITH A LASER MICROPROBE. Megrue, G. H. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard College Observatory, Cambridge, Mass.). Science, 157: 1555-6(Sept. 29, 1967).

A ruby-pulsed laser and high-sensitivity mass spectrometer were used to analyze isotopic abundances of rare gases from microgram samples of polished sections. The feasibility of the technique is demonstrated by the analysis of primordial helium and neon from the Kapoeta and Fayetteville meteorites. (auth)

42885 STUDY OF ANALYTICAL METHODS OF STEEL-MAKING MATERIALS. V. SPECTROPHOTOMETRIC DETERMINATION OF TITANIUM IN FERRO-NIOBIUM WITH DIANTIPYRYLMETHANE. Kajiyama, Rokuro; Yamaguchi, Katsumasa (Nippon Yakin Kogyo Co., Ltd., Kawasaki, Japan). Bunseki Kagaku, 16: 908-12(Sept. 1967). (In Japanese).

From 0.02 to 0.60% titanium was determined in ferro-niobium as an impurity with diantipyrylmethane as a colorimetric reagent. Titanium and niobium are similar in their analytico-chemical properties, and often interfere with each other in spectrophotometric determinations. With this reagent, however, niobium did not interfere, provided it had been previously converted to its oxalate. A sample was fused with potassium pyrosulfate, and digested into a sulfuric acid solution containing ammonium oxalate. An appropriate aliquot (corresponding to 10 ~ 100 μg Ti) was taken out, and iron was reduced by adding ascorbic acid. Eight milliliters of hydrochloric acid (1 + 1) and 20 ml of the 1% reagent solution were added, and the whole volume was made up to 50 ml with water. The amount of titanium was obtained by measuring absorbance at 385 mμ after 45 minutes. (auth)

42886 INSTRUMENTAL METHOD OF ACTIVATION DETERMINATION OF MACROCOMPONENT CONTENT IN METEORITES ACCORDING TO SHORT-LIVED ISOTOPES. Chaika, M.; Sabo, E.; Lavrukhina, A. K. (Central Inst. of Physics, Budapest, Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 9, 1106-16(Sept. 1967). (In Russian).

A series of experiments on the simultaneous determination of the principal components of meteoritic material, such as Mg, Ni, Co, Al, Mn, Fe, and Si have been carried out according to the short-lived radioisotopes being formed in the (n,γ) and (n,p)-reactions correspondingly by irradiation of samples weighing up to 2 mg with reactor neutrons in a Cd-container or without it and by a subsequent nondestructive measurement of the radioisotope gamma radiation on a gamma spectrometer with a 256-channel impulse analyzer. Formulas for calculating the share of reactions with fast neutrons are proposed. Limits of Si, Mg, Fe ratios have been established during their determination. The possibility of utilizing the instrumental activation analysis for the determination of macrocomponents in individual minerals and separate meteoritic chondrules is discussed. (auth)

42887 NEW SPECTROPHOTOMETRIC METHOD FOR DETERMINATION OF SMALL AMOUNTS OF VANADIUM(V) USING NICOTINIC ACID HYDRAZIDE (HKN). Krych, Zdzislaw; Lipiec, Tadeusz (Dept. of Inorganic and Analytical Chemistry, Lodz, Poland). Chem. Anal. (Warsaw), 12: 535-8(1967). (In Polish).

A spectrophotometric method for the determination of V(V) is based on the colored complex formed with nicotinic acid hydrazide in aqueous solutions at pH = 2. The composition of the complex was determined to be 1:1 by the method of continuous variation and spectrophotometric titration. The absorption maximum of the complex occurs at 420 mμ, and the molar absorptivity of the complex is 750 at this wavelength. Beer's Law is obeyed over a V concentration of 3 to 50 μg/ml. Interferences are Cu^{2+}, Fe^{3+}, and UO_2^{+}. (auth)

42888 THE EFFECT OF DISPROPORTIONATION OF U(V) IONS AND OF DIFFERENT IONS ON THE POLAROGRAPHIC DETERMINATION OF URANIUM IN SOME ORGANIC ACID SOLUTIONS. Sohkowska, Aleksandra (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw), 12: 487-93(1967).

Effects are described of light, factors affecting U(V) disproportionation rate, and of other ions on the polarographic wave of U(VI) reduction. Dispersed daylight did not induce errors in analysis, provided the solution was not exposed to the direct action of the sunlight. Choice of appropriate supporting electrolyte and pH depends on the kind of impurities accompanying U. Application of solutions of organic acids is often very useful. Because of their complexing capabilities and the shifting of the deposition potential of particular ions it is possible to determine U in presence of other ions, without preliminary separation. Electrolytes suitable for determination of U in presence of various impurities are listed. (auth)

42889 THE MEASUREMENTS OF EROSION OF CONDENSER TUBE BY NEUTRON ACTIVATION ANALYSIS. 2. Kawai, Keiji (Marine Tech. Coll., Hyogo, Japan). Nippon Kokai Gakkai Shi, No. 35, 51-56(July 1966). (In Japanese).

Some quantities of Mn in seawater were measured by neutron-activation analysis in order to estimate the erosion of condenser tubes of steam engines. The samples, seawater with added $MnCl_2$, absorbed on a piece of filter paper, were bombarded in thermal neutron flux of 4×10^{12} n/cm^2 · sec for 20 min. After bombardment, the Mn was chemically separated from ^{24}Na and ^{38}Cl and the activities of ^{56}Mn were measured using a RCL-256 channel pulse-height analyzer. Mn in seawater could be determined up to 0.00005 mg in 1 cc of seawater. (NSA of Japan)

42890 DETERMINATION OF URANIUM CLARKEITE CONCENTRATIONS IN IONIC CRYSTALS. Berzina, I. G.; Berman, I. B.; Gurvich, M. Yu. At. Energ. (USSR), 22: 504-5(June 1967). (In Russian).

The very low clarkeite concentrations in ionic crystals may be determined on the basis of tracks formed by artificially fissioned uranium; these tracks may be rendered visible by etching. The etched surfaces of crystal specimens were subjected to neutron bombardment and the uranium concentration determined by the formula $C = 2\rho\mu/N_0 JnσkdR\epsilon$, where ρ represents the fission-product track density due to the irradiation; μ is the molecular weight of the material; N_0 is Avogadro's number; J the isotopic concentration of ^{235}U; σ is the effective fission cross section of ^{235}U for thermal neutrons; n is the integral thermal neutron flux; k is the number of atoms per molecule; d is the specific weight; R is the effective track of a fission fragment; and ϵ is the efficiency of development of tracks. An integral dose of 10^{15} was used; the fission of ^{238}U by fast neutrons was found to be negligible. The value of ϵ, determined by irradiating the crystal with a collimated beam of ^{244}Cm fission products, was found to be 60, 50, 65, and 70% for NaCl, KCl, LiF, and $CaCO_3$, respectively. The concentrations found amounted to 5.2×10^{-9} in natural NaCl, 4.4×10^{-10} in synthetic NaCl, 6.1×10^{-10} in synthetic KCl, 1.5×10^{-6} in fine-grained $CaCO_3$, 3.8×10^{-10} in the coarse grained material, and 1.3×10^{-9} LiF in units of atom per atom. The error is estimated at 50%. (TTT)

42891 PULSE-HEIGHT ANALYSIS OF GAMMA-RAY SPECTRA OF SAMPLES CONTAINING VERY LOW LEVELS OF RADIOACTIVITY. Schonfeld, E. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Appl., 3: 635-6(Oct. 1967). (ORNL-P-2991).

Several problems in detector design, operation, and data evaluation were encountered in the analysis by gamma spectroscopy of samples containing very low levels of radioactivity. Some of these problems are: compensation for variations in the background intensity during counting, determination of how large the anticoincidence mantle and/or shield should be to reduce the background, determination of the optimum counting times of the sample and background, and compensation for spectral shifts occurring during the long counting times required for these samples. Possible methods for satisfactorily solving these problems are described. A spectrum-resolution program, written in FORTRAN 62, 63, II, or IV, which can be used to analyze these low-activity samples for isotopic constituents, is available. (auth)

42892 INSTRUMENTAL REACTOR NEUTRON ACTIVATION-ANALYSIS STUDIES ON 72 ELEMENTS IN A REFINED HYDROCARBON. Yule, H. P. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nucl. Appl., 3: 637-40(Oct. 1967).

Concentration measurements and determinations of upper limits to concentrations are obtained instrumentally by gamma spectrometry following reactor neutron activation. The concentrations of identifiable spectral components are computed, as are

also upper limits to the concentrations of those elements that made no observable contribution to the spectra. The upper limits are computed from the shape of an observed spectrum and from a knowledge of the yield and spectral shape of prominent radioactivities from each element under the conditions of irradiation. As an example of this analytical technique, upper limits obtained on a refined hydrocarbon were: 1 element < 1 ppB, 6 elements < 10 ppB, 20 elements < 100 ppB, and 42 elements < 1000 ppB. Identified components were sodium (0.5 ppM), aluminum (14 ppM), and zinc (39 ppM). (auth)

42893 RECENT DEVELOPMENTS OF ANALYSIS AND SEPARATION OF RARE EARTH ELEMENTS. I. OUTLINE OF THE ANALYSIS FOR RARE EARTH ELEMENTS. Kaneko, Keiji; Okada, Hiroko. Denki Shikensho Iho, 29: 172-9(1965). (In Japanese).

A supplement is given to the review, "Analysis and Separation of Rare Earth Elements" (Cir. Electrotech. Lab., No. 155 (1963)). More than 500 references published from 1945 to 1961 are classified according to procedures, published years, and countries where investigations were made. Developments and recent tendencies, or prevailing methods, of the determination of rare earth elements based on the literature investigation are discussed. (Sum. Rep. Electrotech. Lab. (Tokyo) No. 20, 1965)

42894 RADIOACTIVATION ANALYSIS OF ZINC BASED ON THE QUANTITATIVE ISOTOPE DILUTION PRINCIPLE. Kudo, Kiyoshi (Electrical Communications Lab., Tokyo). Radioisotopes (Tokyo), 16: 199-203(May 1967).

Trace amounts of Zn were determined by radioactivation analysis based on quantitative isotope dilution principle. The irradiated sample was divided into two parts, and a known amount of carrier M added to one. An amount m, which is less than the amount of the element in question M_x is separated from each part, and then radioactivities of both parts a and a' are measured. The unknown amount M_x is calculated from $M_x = a'M/(a-a')$. The experiment to determine the reaction ratio between Zn and dithizone was carried out at various conditions and it was observed that the ratio was constant in the solution of pH 8.5. The specific activity was proportional to the amounts of Zn added, and the reproducibility of the results was satisfactory. This method was applied to the determination of Zn in the Zn-doped gallium arsenide as semiconductor material and satisfactory results were obtained. (NSA of Japan)

42895 SPECTROPHOTOMETRIC STUDY OF CERIUM(III) AND THORIUM(IV) CHELATES OF TRANS-1,2-DIAMINOCYCLOHEXANE-NNN'N'-TETRAACETIC ACID. Hsu, Tung-ming; Yang, Tsung-ch'ang (National Taiwan Univ., Formosa). J. Chin. Chem. Soc. (Taiwan), 12: 69-81(1965).

The chelate of the reagent with Ce^{3+} in aqueous solutions of pH 4.25 shows a characteristic absorption maximum at 305 mμ. The extinction is reduced by addition of small amounts of Th, and a method for Th determination based on this is described. The Th solution is used for the spectrophotometric titration of the Ce^{3+} chelate at reagent concentrations of ≈0.3 mM. The ratio of metal to reagent in the chelate is 1:1. The formation constants of the chelate were calculated. (Analytical Abstr.)

42896 A TRIAL METHOD OF DETERMINING URANIUM AND THORIUM CONTENT IN ROCKS BY THE RADIOACTIVE MEASUREMENTS. III. Nishimura, Susumu (Univ. of Osaka Prefecture); Hatsuda, Jinichiro. Radioisotopes (Tokyo), 16: 156-60(Apr. 1967). (In Japanese).

For basic lavas in radioactive disequilibrium, the content of U and Th was determined by the neutron activation method and the content of ^{214}Pb and ^{212}Pb by spectrometry. These lavas revealed radioactive disequilibrium by means of alpha and gamma interpretation. It appears that Th/U ratio of basaltic lava of historical age is higher than that of andesitic one, and that the Ra content of tholeiite lava is nearly normal compared with its U content, while that of alkali and high-alumina lava is highly excessive. (NSA of Japan)

42897 DIRECT COMPLEXOMETRIC DETERMINATION OF ZIRCONIUM(IV) IN RELATION TO POLYMERISATION. Sinha, B. C.; Das Gupta, S. (Central Glass and Ceramic Research Inst., Calcutta). Analyst, 92: 558-64(Sept. 1967).

Polymerisation and de-polymerisation of zirconium on boiling and aging in various concentrations of nitric, hydrochloric, and sulphuric acids were systematically studied and the optimum experimental conditions for complete de-polymerisation and titration of zirconium ions worked out. A simple and accurate method is described for the direct titration of zirconium ions with EDTA. Most elements, other than phosphorus and fluorine, do not interfere. The method has been successfully used for determining zirconium in zircon and commercial zirconium dioxide. (auth) (UK)

42898 RAPID DETERMINATION OF ARSENIC IN COPPER AND BRASS BY NEUTRON-ACTIVATION ANALYSIS. Grimanis, A. P.; Souliotis, A. G. (Democritos Nuclear Research Center, Athens). Analyst, 92: 549-52(Sept. 1967).

A rapid neutron activation analysis method is presented for the determination of microgram amounts of arsenic in copper and brass. Neutron-irradiated samples are dissolved in hot perchloric acid in the presence of an arsenic carrier. The resulting solution is made 7.4M with respect to perchloric acid and 1.2M with respect to hydrobromic acid. The arsenic-76 and the arsenic carrier are extracted quantitatively into benzene. After washing the benzene layer with 7.4M perchloric acid-1.2M hydrobromic acid mixture, arsenic-76 is counted directly in the organic phase. The radiochemical purity of the arsenic-76 extract was demonstrated by using a multichannel analyser, together with decay studies. After irradiation the time required to complete the analysis is less than 15 minutes, which is at least four times shorter than that previously reported for activation analysis methods. The proposed method was successfully applied to the determination of arsenic in copper and brass primer cups and primer pockets (arsenic content 1 to 50 ppM). (auth) (UK)

42899 FAST NEUTRON ACTIVATION ANALYSIS FOR NITROGEN IN EXPLOSIVES AND PROPELLANTS. Rison, M. H.; Barber, W. H.; Wilkniss, P. E. (Naval Propellant Plant, Indian Head, Md.). Radiochim. Acta, 7: 196-8(Aug. 1967).

Nitrogen was determined in explosives and propellants by fast neutron activation analysis which makes use of the nuclear reaction, $^{14}N(n,2n)^{13}N$. Interfering reactions and the problems arising from the explosive nature of the samples are discussed. (auth)

42900 THE USE OF Ge(Li) DETECTORS IN ACTIVATION ANALYSIS. Girardi, F.; Guzzi, G.; Pauly, J. (Joint Nuclear Research Center, Ispra, Italy). Radiochim. Acta, 7: 202-9 (Aug. 1967).

Germanium lithium-drifted semiconductor detectors of various dimensions and operating in a "dip-stick" type cryostat were used in activation analysis. The results obtained are presented. Even if the efficiency of the detectors is low, they can be applied in many activation analysis problems with advantages over the scintillator detectors. Techniques for the rapid characterization of the detectors, including evaluation of efficiency and resolution versus gamma energy are described. The flow-sheet of a computer program set up for that purpose is given. (auth)

42901 DETERMINATION OF TRACES OF SELENIUM IN BIOLOGICAL TISSUE BY NEUTRON ACTIVATION. Steinnes, E. (Institut for Atomenergi, Kjeller, Norway). Int. J. Appl. Radiat. Isotop., 18: 731-4(Oct. 1967).

The determination of selenium in biological tissue is discussed. The existence of six stable isotopes of selenium offers several possibilities for activation analysis. A technique based on ^{75}Se is described, with a detection limit of 0.5 nanogram, using a neutron flux of 2×10^{12} n/cm^2 and a sensitive detection system. Details are given of the irradiation procedure, radiochemical separation, and activity measurement. (UK)

42902 SIMULTANEOUS SPECTROGRAPHIC DETERMINATION OF NIOBIUM, ZIRCONIUM, AND YTTRIUM (IN ORES AND CONCENTRATES). Yudelevich, I. G.; Ponomareva, T. P. Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal, No. 9, 195-8(1965). (In Russian).

Standards or samples are mixed (1:1) with carbon containing 0.75% of MoO_3, and pressed into cavities (dia 1.3 mm and depth 6 mm) in the end of carbon electrodes (dia 2.6 mm). The spectra are excited in an ac arc, and the following lines (Å) are used—Zr 2678.6, Nb 2950.9, Y 2422.2, and Mo 2683.2 and 2930.5. Calibration graphs are constructed for the ranges 0.1 to 7% of Zr, 0.02 to 1% of Nb and 0.1 to 2% of Y. Samples with higher contents of these metals are diluted with a blank powder. For 0.01 to 0.1% of Y, the spectra are recorded for 2.5 min with a high-dispersion spectrograph (second order), and the lines measured are Y 3216.7 and Mo 3214.4 Å. Standards are prepared by adding the oxides to a blank powder. Chemical and spectrographic results agree. (Analytical Abstr. Vol. 14 No. 1, 1967)

42903 RADIOMETRIC DETERMINATION OF LEAD IN MATERIALS OF LEAD PRODUCTION. Velyus, L. M.; Ustimov, A. M. Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal., No. 9, 132-5(1965). (In Russian).

Place the sample (10 to 15 g) in a glass cell (height 5 cm, dia 1.6 cm) having a Textolite bottom of thickness 0.5 mm, tamp down the sample to a known height (1.2 to 2 cm), and set up the cell at the outlet of a lead container containing ^{204}Tl of activity 100 mCi. Measure, over a period of 3 min., the x radiation produced by the interaction of the β radiation of the ^{204}Tl with

the sample. The determination takes 7 min. (Analytical Abstr. Vol. 14 No. 1, 1967)

42904 DETERMINATION OF RARE EARTH METALS IN ORES. Bortnik, L. S. Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal., No. 9, 199-203(1965). (In Russian).

The sample, mixed with carbon (1 : 1), is placed in a carbon electrode of special shape, and the spectrum is excited in an ac arc discharge. The spectra are recorded in the ranges 2400 to 3000, 3200 to 3400, and 4200 to 4400 Å (second order). For most of the rare earth metals the sensitivity of the determination is 0.01%. The range of determinable concentration is from 0.001% (Y, La, Lu) to 1%; Yb can be determined in the range 10^{-4} to 5×10^{-3}%. The internal standard is Eu or Mo, added as oxide in concentration, 0.2 or 0.5% for the first region of the spectrum, 5 or 0.5% for the second, and 5 or 0.2% for the third, respectively. The error of the analysis is ±8%; the accuracy is checked by comparison with results obtained when total rare earth metals are first separated on La_2O_3 as collector. (Analytical Abstr. Vol. 14 No. 1, 1967)

42905 COLORIMETRIC DETERMINATION, WITH ARSENAZO I, OF TOTAL RARE EARTH METALS IN INDUSTRIAL PRODUCTS OF WORKING OF VANADIUM–RARE EARTH METAL ORES. Krasil'nikova, L. N.; Vostroknutova, M. Ya. Sb. Nauch. Tr. Vses. Nauch.-Issled. Gorno-Met. Inst. Tsvet. Metal., No. 9, 41-8(1965). (In Russian).

Dissolve 0.1 to 0.5 g of sample in $HCl-HNO_3$, evaporate to fumes with 5 to 10 ml of concentrated H_2SO_4, boil the residue with H_2O, and filter. Precipitate rare earth metal hydroxides from the filtrate with aqueous NH_3 (if the sample contains no Fe, add a solution of 5 to 10 mg of $FeCl_3$); collect the precipitate and dissolve it in 5 to 6 ml of hot HCl (1 : 1) and aqueous H_2O_2. Boil to decompose H_2O_2, dilute to ≈50 ml, add 0.5 ml of 28% $CaCl_2 \cdot 6H_2O$ solution, and neutralize to Congo red with saturated Na acetate solution. Dilute with hot H_2O to ≈100 ml, add 15 ml of oxalic acid reagent (40 g of powdered oxalic acid dried at 90 to 100° and dissolved in 100 ml of anhydrous acetone), boil for 30 min, and set aside overnight. Vanadium does not interfere in the precipitation of oxalates if present in amount >1000 times that of the rare earth metals. Collect the precipitate, ignite it, and dissolve the residue in 6 to 7 ml of HCl (1 : 1) plus a few drops of aqueous H_2O_2. Evaporate the solution almost to dryness, dissolve the residue in HCl (1 : 200), and dilute to 50 or 100 ml with this acid. Dilute each of two aliquots (≡30 to 40 μg of rare earth metals; >10 ml) with HCl (1 : 200) to 10 ml, and to each add 1 ml of ascorbic acid solution. Add 1 ml of 10% sulfosalicylic acid solution to one aliquot and 1 ml of 10% tartaric acid solution to the other, and then to each add 3 ml of 0.05% arsenazo I solution and 8 ml of 20% hexamine solution; dilute to 50 ml, and after 30 min, measure the extinction of each solution in 3- or 5-cm cells. Subtract the extinction of the tartaric acid solution from that of the sulfosalicylic acid solution, and refer the result to a calibration graph. If sulfate solutions are to be analyzed, the oxalates can be precipitated directly from 5 to 10 ml of solution without preliminary precipitation of the hydroxides. Fluoride solutions and solutions containing EDTA are first evaporated to fumes with H_2SO_4. (Analytical Abstr., Vol. 14 No. 1, 1967)

42906 SPECTROGRAPHIC ANALYSIS FOR RARE EARTH AND ALKALINE EARTH METALS IN STEEL AND ALLOYS. Sorokina, N. N.; Golubeva, V. M. Sb. Tr. Tsent. Nauch.-Issled. Inst-Chern. Met., No. 37, 98-104(1964). (In Russian).

Procedures are described for the determination of Ce, La, Nd, Pr, Er, Dy, Sm, and Y in carbon, low-alloy, and Cr–Ni steels and nickel alloys, and for the determination of Ba and Sr in Cr–Ni steel. The reproducibility of results in the determination of both rare earth and alkaline earth metals is within ±15%. (Analytical Abstr., Vol. 14 No. 1, 1967)

42907 RADIOACTIVE ISOTOPE DILUTION ANALYSIS. R.C.C. Review No. 2. Revised Edition. Gorsuch, T. T. Amersham, Bucks, Eng., The Radiochemical Centre, 1967. 12p. UK.

Radioisotope dilution and its modifications are described as a sensitive technique for the determination of many substances in mixtures. A few examples are described in detail with many more uses suggested. (P.C.S.)

42908 DETERMINATION OF ISOTOPIC CONCENTRATIONS. Goleb, Joseph A. (to U. S. Atomic Energy Commission). U. S. Patent 3,348,447. Oct. 24, 1967.

A method and apparatus for determining isotopic concentration of two isotopes of an element by means of absorption spectrometry are described. A hollow-cathode absorption tube containing a reference isotope sputtered by xenon ions and two hollow-cathode emission tubes, one containing the reference isotope and the other containing the sample to be analyzed, are used. (AEC)

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Refer also to abstracts 42871, 42872, 42982, 43033, and 44187.

42909 (AD–649050) MAGNETIC SUSCEPTIBILITIES OF SOME RARE EARTH OXIDES. Interim Report. Report No. Scientific-11-Ser-3. Holmes, Lewis Meredith (Harvard Univ., Cambridge, Mass. Gordon McKay Lab. of Applied Science). Dec. 1966. Contract AF19(628)-3874. 250p. (AFCRL-67-0038). CFSTI.

The magnetic susceptibilities of the compounds $R_xNa_xMoO_4$, with R = Gd, Tb, Dy, Ho, Er, Tm, and Yb, were measured between 2 and 300°K for spherical, single-crystal samples. The compounds are paramagnetic and show large, axial anisotropy at low temperatures. The magnetic susceptibilities of samarium and europium gallium garnets ($R_3Ga_5O_{12}$, with R = Sm and Eu) were measured between 2 and 300°K. The magnetic susceptibility of polycrystalline Eu_3O_4, which is isomorphous with orthorhombic calcium ferrite has a peak at 5°K, which is ascribed to antiferromagnetic ordering. However, the magnetic susceptibility above 20°K indicates predominantly ferromagnetic interactions. A simple model, consistent with this result involves ferromagnetic chains of spins, polarized along the c axis, with neighboring chains antiferromagnetically arranged. Measurements on single-crystal fragments show that the compound undergoes a metamagnetic transition at a critical field Hc along the c axis. (auth) (TAB)

42910 (CONF-670722–1) DERIVATIVES OF PENTAFLUOROSULFANYLAMINE, SF_5NH_2. Clifford, A. F.; Zeilenga, G. R.; Goel, R. G. (Virginia Polytechnic Inst., Blacksburg. Dept. of Chemistry). [1966]. Contract AT(40-1)-3603. 6p. Dep. CFSTI.

From 4th International Fluorine Chemistry Symposium, Estes Park, Colo.

The reaction of SF_5NH_2 and SF_4 provides an improved method for the preparation of $SF_5N{=}SF_2$. Fluorination of $SF_5N{=}SF_2$ with AgF_2 gives largely SF_6 and N_2, but with F_2 the reaction is complex giving the new compound $(SF_5N{=})_2SF_2$ as one product. The reaction of SF_5NH_2 with SCl_2 gives $SF_5N{=}SCl_2$, a yellow, highly reactive liquid which attacks mercury and reacts with AgF_2 to give $SF_5N{=}SF_2$. The reaction of NSF_3 and ClF yields pentafluorosulfanyldichloroamine, SF_5NCl_2. The compound is a light yellow liquid with a boiling point of 64°C and a melting point of –120°C. It is sensitive to mechanical shock and is thermally unstable at 80°C. Hydrolysis and the reaction of SF_5NCl_2 with mercury were slow. (auth)

42911 (COO–622–6) [MECHANISM OF ELECTRON TRANSFER IN INORGANIC OXIDATION–REDUCTION REACTIONS]. Final Report. [Reynolds, Warren L.] (Minnesota Univ., Minneapolis). [1967]. Contract AT(11-1)-622. 11p. Dep. CFSTI.

Developments are reported for studies on: catalysis of Fe(II) + Fe(III) isotope exchange by EDTA ions; catalysis of Fe(II) + Fe(III) isotope exchange by sulfate ions; deuterium effects on Fe(II) + Fe(III) isotope exchange; catalysis of Fe(II) + Fe(III) isotope exchange by fluoride ion; Fe(II) + Fe(III) isotope exchange in N-methylacetamide; Fe(II) + Fe(III) isotope exchange in dimethyl sulfoxide; catalysis of Fe(II) + Fe(III) isotope exchange by chloride ion in dimethyl sulfoxide; preparation of unusual oxidation states of Fe; Al(III) solutions in dimethyl sulfoxide; Ni(II) and Co(II) solutions in dimethyl sulfoxide; Ni(II) and Co(II) solutions in acetonitrile; Fe(II) + Fe(III) isotope exchange in acetonitrile; and theoretical studies. (P.C.H.)

42912 (IS-T-177) REACTIONS OF TRANS-DI-μ-CHLORO-DICHLOROBIS(ETHYLENE)DIPLATINUM(II). McMane, Douglas Glenn (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 109p. Dep. CFSTI.

Thesis.

Equilibrium quotients for the solvation of $Pt(C_2H_4)Cl_3^-$ in water and ethanol have been measured at 25 and 35°. The equilibrium quotient for the solvation in ethanol is 0.02 of the value of the quotient in water. Spectrophotometric evidence and molecular weight measurements indicate that $[Pt(C_2H_4)Cl_2]_2$ dissociates to trans-$Pt(C_2H_4)Cl_2(C_2H_5OH)$ in ethanol solvent at concentrations lower than 25 mMoles Pt. The cis chloride exchange rate of a labile equilibrium mixture of $Pt(C_2H_4)Cl_3^-$ and trans-$Pt(C_2H_4)Cl_2(C_2H_5OH)$ in ethanol has been characterized by the expression $R_{ex} = k[Pt(C_2H_4)Cl_3^-][\text{trans-}Pt(C_2H_4)Cl_2(C_2H_5OH)]$. The value of k is 0.077 M^{-1} sec^{-1} at 25° and 0.31 M^{-1} sec^{-1} at 35°. No evidence was found for an exchange path first order in complex. A mechanism for the exchange path has been proposed. (70 references). (auth)

42913 (IS-T-178) PROFILE OF A LIQUID DROPLET DURING FORMATION AND SEPARATION. Halligan, James Edmund

(Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 61p. Dep. CFSTI.

Thesis.

The profile of a forming droplet was determined using a pressure balance similar to that derived by Laplace for the static droplet. A term was added to the balance to account for the pressure on the interface due to the motion of the fluid within the droplet. The entire pressure balance was then combined with differential equations describing the geometry of the droplet. Computed profiles compared favorably with those obtained experimentally. An additional result was the definition of a parameter f indicating the importance of internal fluid motion on the shape of the profile. A method of estimating this parameter without solving the equations was developed. An equation was also derived to describe the profile of a separating droplet—a droplet with a volume only slightly larger than the critical volume and no flow effects due to formation. The computed and experimental profiles were similar until the droplet developed a minimum value in the profile. The nature of the additional resistance needed in the equations to describe the remaining portion of the separation process was investigated. (auth)

42914 (LA-DC-8620) HIGH TEMPERATURE HEAT CONTENT AND HEAT CAPACITY OF URANIUM DIOXIDE AND URANIUM DIOXIDE–PLUTONIUM DIOXIDE SOLID SOLUTIONS. Ogard, A. E.; Leary, J. A. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 26p. (CONF-670915-5). Dep. CFSTI.

From Symposium on Thermodynamics of Nuclear Materials with Emphasis on Solution Systems, Vienna, Austria.

In view of existing disagreements, the heat content and heat capacity of UO_2 and PuO_2–UO_2 solid solutions were determined by high-temperature drop calorimetry. The heat content and heat capacity of $\alpha - Al_2O_3$ above 1200°K were also measured. An increase in both the heat content and the heat capacity was observed for substitution of Pu for U in the stoichiometric dioxide lattice. Since UO_2 and PuO_2 form an ideal solid solution it was estimated from these results that the heat content of PuO_2 will be ~5 to 20% higher than for UO_2 and the heat capacity will be ~10 to 40% higher in the temperature range 1400 to 2400°K. Data are tabulated, and the results were compared with those obtained by others. (P.C.H.)

42915 (NYO-2279-3) PROPERTIES AND APPLICATIONS OF MULTILAYER ELECTRODES. Final Report, February 1, 1966–July 31, 1967. Gregor, H. P. (Polytechnic Inst. of Brooklyn, N. Y.). Contract AT(30-1)-2279. 95p. Dep. CFSTI.

Progress is reported on: composition of long-chain carboxylate and phosphate multilayers from substrates containing Ca, Na, and K; properties of long-chain phosphorus acid monolayers; construction and properties of multilayer membrane electrodes; and differential free energies of hydration of ions at low hydration numbers. (M.C.G.)

42916 (ORNL-TM-1947) ELECTROSTATIC FORCES OF ADHESION BETWEEN PARTICLES. Fish, B. R. (Oak Ridge National Lab., Tenn.). Aug. 16, 1967. Contract W-7405-eng-26. 26p. Dep. CFSTI.

Magnitudes of the various adhesive forces for a given size particle are considered. Estimates of the forces are given in the order of their discussion in the paper. It was concluded that actual relative importance depends on many separate factors in addition to the diameter, which enters as the first power in some cases, as the second in others and, in the case of gravitational force, as the third power. For the purpose of comparison the particles were taken to be 10 μ dia glass spheres. Capillary forces are shown to vary from about 0.2 to 0.9 dynes. The van der Waals force depends on the diameter of the contacting roughness elements. Repulsive forces resulting from the accumulation of free surface charge on contacting conductors are dependent on the available total concentration of charge. (M.C.G.)

42917 (ORNL-TM-1976) LITERATURE SURVEY OF THE FLUORIDES AND OXYFLUORIDES OF MOLYBDENUM. Weaver, C. F.; Friedman, H. A. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 23p. Dep. CFSTI.

A literature review on the fluorides and oxyfluorides of molybdenum is summarized. Data on MoF_2, MoF_4, Mo_2F_9, MoF_5, $MMoF_6$, K_2MoOF_5, MoF_6, MoF_6–UF_6, M_2MoF_8, $MoOF_4$, MoO_2F_2, and container materials are presented. (42 references). (M.C.G.)

42918 (UCRL-17718) PREPARATION AND CRYSTALLOGRAPHIC ANALYSIS OF CALIFORNIUM SESQUIOXIDE AND CALIFORNIUM OXYCHLORIDE. Copeland, J. C. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 42p. Dep. CFSTI.

Thesis.

Three samples of the low-temperature, cubic, Mn_2O_3-type californium "sesquioxide" were prepared. Two of these samples, prepared by the hydrolysis of other californium compounds, gave the same lattice parameters, within the error limits, with the average lattice parameter being a = 10.838 ± 0.02 Å. The third sample, reacted in oxygen, had the lattice parameter a = 10.809 ± 0.003 Å. In an earlier study, the lattice parameter of an air-ignited oxide sample was significantly smaller than the parameter of the same sample after heating in hydrogen. If these differences in lattice parameter reflect varying stoichiometries, then this might be evidence for higher and/or lower oxidation states of californium. The exact stoichiometries of the oxide samples prepared in this study are not known. Three samples of californium oxychloride were prepared and studied by x-ray diffraction techniques. The CfOCl had the tetragonal PbFC1-type structure and gave the average lattice parameters a = 3.956 ± 0.002 and c = 6.662 ± 0.009 Å. The error limits reported for the lattice parameters of CfOCl and "Cf_2O_3" from the hydrolysis reactions are based on a statistical analysis of the consistency of the group of measurements. The limits placed on the lattice parameter of the "Cf_2O_3" sample from the reaction with oxygen represent the 95% confidence level and reflect the internal consistency of the data for that particular sample. (auth)

42919 (UCRL-17813) A BEAM STUDY OF $N_2^+ + H_2$, HD, D_2 REACTION DYNAMICS. Gentry, W. R. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 70p. Dep. CFSTI.

Thesis.

An ion beam-collision cell method was used to measure the product energy and angular distributions from reactions of N_2^+ with H_2, HD, and D_2 in the primary ion energy range from 25 to 135 eV. The data include three contour maps each for the H_2 and D_2 experiments (taken at low, intermediate, and high energies) showing the entire distribution of product intensity in the center-of-mass coordinate system. The distributions have a crater-like shape around the center-of-mass point. At large scattering angles the intensity varied slowly with angle, and the velocity at the rim of the crater was independent of angle in the center-of-mass system. All of the distributions had a peak at 0° scattering angle, which showed little spreading in energy or angle over the spread in the primary ion beam. The intensity of this peak was to 3 to 500 times that for large-angle scattering. Kinematic analysis of the distributions showed that all product ions are formed with high excitation energies. The amount of transfer of kinetic energy of the reactants to excitation energy of the products was found to be ~1.75 eV for large-angle scattering, independent of the primary ion energy. For small-angle scattering, energy transfer agreed with predictions of the stripping model for collisions at low energies, but at high collision energies it reached a constant maximum value of ~2.5 eV. This result is interpreted as evidence for $N_2 + H^+$ as the principal dissociation products of N_2H^+. Only isolated features of the product ion distributions agreed with simple collision models, and at high energies strong recoil was kinematically required by the data, even for the forward scattering peaks. (auth)

42920 THE CHEMICAL PROPERTIES OF HEAVY ALKALI METALS INSERTED IN GRAPHITE; REACTIONS WITH SOME GASEOUS ELEMENTS. Herold, A.; Colin, M.; Daumas, N.; Diebold, R.; Saehr, D. (Univ., Nancy). pp 309-16 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The chemical properties of the heavy alkali metal–graphite lamellar systems were investigated. Three possibilities of heavy alkali metal reactors with gas were evaluated according to the heat of reaction in the gas–metal systems. Effects of variations of heat of reaction on metal–graphite systems were analyzed. (M.L.S.)

42921 A STEREOSPECIFIC BASE-CATALYZED DEUTERIUM EXCHANGE OF TRICYCLO[4.3.1.0]DECA-2,4,7-TRIENE. Radlick, Phillip; Rosen, William (Univ. of California, Riverside). J. Amer. Chem. Soc., 89: 5308-9(Sept. 27, 1967).

The base-catalyzed exchange of tricyclo[4.3.1.0]deca-2,4,7-triene (I) led to a stereospecific abstraction of proton and stereospecific incorporation of deuterium. The hydrocarbon (I) was allowed to react with a saturated solution of NaOD in dimethyl-d_6 sulfoxide at 30°C and the reaction was followed by NMR. The hydrocarbon that was isolated contained one deuterium atom at C_7. 9-Methyltricyclo-[4.3.1.0]deca-2,4,7-triene (II) was prepared and subjected to an exchange experiment. When treated with NaOD in dimethyl-d_6 sulfoxide even after 3 months at 30°C, II was not observed to undergo any proton exchange for deuterium. It was contended that the stereospecificity of the exchange of hydrogen for deuterium in I was due to the rigid stereoelectronic requirement that the cyclopropane ring places upon the molecule. H_{10} is more readily abstracted by

the base than H_9 because the electron pair in the orbital between C_9 and H_{10} can overlap much more effectively in the transition state with the electron pair in the zero-bridge bond (C_1-C_6) of the cyclopropane ring than can the electron pair between C_9 and H_9. (D.H.M.)

42922 1,3-ASYMMETRIC INDUCTION IN A TRANSAMINATION REACTION. Guthrie, Robert D.; Meister, Willi; Cram, Donald J. (Univ. of California, Los Angeles. Univ. of Kentucky, Louisville). J. Amer. Chem. Soc., 89: 5288-90(Sept. 27, 1967).

Kinetic studies of isomerization of a variety of labeled imines in several solvents were made, and the pseudo-first-order rate constants for isomerization were determined. Additional independent one-point rate constants were determined for isotopic exchange of starting material and for racemization of starting material. Some conclusions were: the proton transfer in the base-catalyzed transamination was essentially completely stereospecific and involved only a single face of an azaallylic anion; the starting material underwent isotopic exchange with high retention; extensive isotopic exchange with the solvent occurred while a proton or deuteron was being transferred; and a substantial kinetic isotope effect for isomerization was observed. (D.H.M.)

42923 MASS SPECTROMETRY IN STRUCTURAL AND STEREOCHEMICAL PROBLEMS. CXXXVI. PRIMARY HYDROGEN ISOTOPE EFFECTS IN THE MCLAFFERTY REARRANGEMENT. MacLeod, J. K.; Djerassi, Carl (Stanford Univ., Calif.). J. Amer. Chem. Soc., 89: 5182-90(Sept. 27, 1967).

Measurements, at 70 eV and lower ionizing energies, of the primary hydrogen isotope effect in the mass-spectrometric cyclic transfer process known as the McLafferty rearrangement indicate that a broad range of isotope effect (IE) values from 0.5 to 1.0 is encountered among ketones, esters, and aromatic and heterocyclic substrates. An attempt was made to rationalize the results by analogy with related processes in solution chemistry and photochemistry. (auth)

42924 STUDIES OF THE BEHAVIOR OF TRIVALENT URANIUM IN AN AQUEOUS SOLUTION. I. ITS REDUCTION AND ITS STABILITY IN VARIOUS ACID SOLUTIONS. Sato, Akiko (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 40: 2107-10(Sept. 1967).

Various methods for the reduction of hexavalent uranium to the trivalent state were examined. It was found that the liquid-zinc-amalgam method is simple and rapid, and gives a high yield with a good reproducibility in hydrochloric, sulfuric, and perchloric acid solutions. The percentage of reduction is over 99% in a 0.5 N hydrochloric acid solution. It was observed that the trivalent uranium ion is fairly stable in any hydrochloric, sulfuric, and perchloric acid solutions at a low concentration of the acids in the absence of atmospheric oxygen, but that it becomes unstable as the acid concentration increases. Both the percentage of reduction by the liquid-zinc-amalgam method and the stability of trivalent uranium are highest in a hydrochloric acid solution, next highest in a perchloric acid solution, and lowest in a sulfuric acid solution. (auth)

42925 THE CHEMISTRY OF PROTACTINIUM. IV. ON THE ABSORPTION SPECTRA OF TETRAVALENT PROTACTINIUM IN AQUEOUS SOLUTIONS. Mitsuji, Toshikazu (Tohoku Univ., Sendai). Bull. Chem. Soc. Jap., 40: 2091-5(Sept. 1967).

The liquid zinc amalgam method was developed as a rapid procedure for the reduction of pentavalent protactinium. Several minutes were sufficient for the complete reduction of 4.2×10^{-4} M pentavalent protactinium in both hydrochloric and sulfuric acid solutions. The stability of tetravalent protactinium in these media was investigated by spectrophotometry. Re-oxidation occurred gradually, even in the absence of atmospheric oxygen, and amounted to 8% in 15 hr. These results may be understood in terms of the slow rate of the $(2Pa^{4+} + 2H^+ \rightleftharpoons 2Pa^{5+} + H_2)$ reaction. The formation of sulfato complexes of tetravalent protactinium was inferred by spectrophotometry with relation to the similarity of the electronic structure between $Pa^{4+}(5f^1)$ and $Ce^{3+}(4f^1)$. (auth)

42926 A SPECTROPHOTOMETRIC STUDY OF THE THORIUM COMPLEXES OF o-, m-, AND p-NITROPHENYL-AZO-CHROMOTROPIC ACIDS. Toei, Kyoji; Miyata, Haruo; Kimura, Hirosumi (Okayama Univ., Japan). Bull. Chem. Soc. Jap., 40: 2085-9(Sept. 1967).

o-, m-, and p-nitrophenyl-azo-chromotropic acids were prepared as colorimetric reagents for thorium. The acid dissociation constants of the reagents were determined spectrophotometrically, their pK_1 values being 8.96, 8.60, and 8.77 for the o-, m-, and p-compounds, respectively at 25°C and when $\mu = 0.1$. The reagents form violet 1:1 complexes in an acidic solution. The apprent stability constants were measured spectrophotometrically. The order of the apparent stability constants of the complexes agrees with that of the first acid dissociation constants of the reagents; m-nitro > p-nitro > o-nitro compounds. (auth)

42927 IR SPECTRA OF ^{15}N-SUBSTITUTED PHOSPHINIMINES. Wiegraebe, Winfried; Bock, Hans; Luettke, Wolfgang (Univ., Munich). Chem. Ber., 99: 3737-49(1966). (In German).

The ir spectrum of $(C_6H_5)_3P=NC_6H_5$ has the P=N valence vibration at 1344 cm^{-1}, with a shift of 20 cm^{-1} in the ^{15}N compound; the N-phenyl bands at 1039, 761, and 564 cm^{-1} are shifted by 6, 3, and 5 cm^{-1} respectively; the asymmetric $P(C_6H_5)_3$ valence vibration at 519 cm^{-1} is shifted by 1 cm^{-1}. The spectrum of $(C_6H_5)_3P=NSO_2C_6H_4CH_3$ has the P=N valence vibration at 1147 cm^{-1} the S-N vibration at 784 cm^{-1}, the P=N-S deformation at 578 cm^{-1}, the symmetrical SO_2 vibration at 1136 cm^{-1}, the S-phenyl vibration at 652 cm^{-1}, the symmetrical SO_2 deformation at 559 cm^{-1}, and the SO_2 pendulum vibration at 528 cm^{-1} shifted by 23, 4, 4, 2, 2, 2, and 1 cm^{-1} respectively in the ^{15}N compound. In $Cl_3P=NSO_2C_6H_4CH_3$, the P=N valence vibration at 1199 cm^{-1}, the S-N valence vibration at 763 cm^{-1} P=N-S deformation at 549 cm^{-1}, the symmetrical SO_2 valence vibration at 1155 cm^{-1}, the S-phenyl vibration at 665 cm^{-1}, the symmetrical SO_2 deformation at 561 cm^{-1}, and the SO_2 pendulum vibration at 523 cm^{-1} are shifted by 16, 7, 3, 3, 2, 2, and 3 cm^{-1}, respectively, in the ^{15}N compound. The synthesis of the compounds is described. (BBB).

42928 STUDY OF NEW INORGANIC AND ORGANOMETALLIC FORMS OF ASTATINE. Norseev, Yu. V.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Chem. Zvesti, 21: 602-10(1967). (In Russian).

Properties of astatine in solutions of nitric acid and in the presence of dichromate were investigated. Under the conditions of the experiment, in the electromigration processes, astatine is positively charged. In the ion-exchange processes on cation exchangers, the astatine cation has a charge of +1. In the course of electrochemical deposition, spontaneous deposition of astatine on the negatively charged surface of platinum saturated with oxygen occurs. On the bases of these investigations, the existence of a univalent astatine cation was postulated. (auth)

42929 CHARACTERIZATION OF ENERGY TRANSFER INTERACTIONS BETWEEN RARE EARTH IONS. Van Uitert, L. G. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Electrochem. Soc., 114: 1048-53(Oct. 1967).

Energy transfer studies employing the sodium rare earth tungstates (scheelite structure) indicate a number of modes of, and requirements for, nonradiative interaction. Direct dipole-dipole interactions are prevalent. However, dipole-quadrupole interactions are observed for the states of the larger rare earth ions that lie high in energy. The relation of lifetime (τ_e) to intensity changes with the mode of transfer. Phonon assisted transfer is enhanced by exchange coupling between rare earth ions in nearest or next nearest neighbor positions. Excitation may migrate between Tb ions in such positions when thermally activated and provided a suitable quenching center (e.g., Nd, Eu) is present. Such migration appears to be directional in comparison to transfer by radiation reabsorption. The latter is essentially random. Methods for analyzing lifetime data for transfer interactions are also discussed. (auth)

42930 REACTION OF HYDROXYLAMINE WITH URANYL IONS. Il'ichev, V. A.; Frolov, Yu. G.; Gromov, B. V. Zh. Neorg. Khim., 12: 1893-6(July 1967). (In Russian).

The kinetics of the reaction of hydroxylamine with uranyl ions in fluoride media were investigated. The orders of the reaction with respect to uranium and fluoride (zero) and with respect to hydroxylamine (0.5) and Cu^{2+} ions (first) were determined. A mechanism for the reduction reaction of U(VI) with hydroxylamine to the tetravalent state was proposed. (tr-auth)

42931 REACTION OF THORIUM HALIDES, NITRATES, FORMATES, AND ISOTHIOCYANATES WITH CARBAMIDES. Molodkin, A. K.; Ivanova, O. M.; Kuchumova, A. N.; Kozina, L. E. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim., 12: 1831-9(July 1967). (In Russian).

The interaction of hydrated tetrahalides, tetranitrates, tetraisothiocyanates, and tetraformates of Th with carbamide was investigated. Compounds with the following composition were synthesized for the first time: $ThCl_4 \cdot 8(NH_2)_2CO$; $ThCl_4 \cdot 6(NH_2)_2CO \cdot 2H_2O$; $ThBr_4 \cdot 8(NH_2)_2CO$; $ThBr_4 \cdot 6(NH_2)_2CO \cdot 2H_2O$; $ThBr_4 \cdot 4(NH_2)_2CO \cdot 4H_2O$; $Th(NO_3)_4 \cdot 6(NH_2)_2CO \cdot 2H_2O$; $Th(NCS)_4 \cdot 4(NH_2)_2CO \cdot 4H_2O$; $Th(HCO_2)_4 \cdot 1.5(NH_2)_2CO$. Some physical-chemical properties of the synthesized compounds (thermal stability, molecular electroconductivity in water and absolute alcohol) were studied; the refractive indices, density, and magnetic susceptibility were determined. On the basis of the infrared absorption spectra it was established that the molecules of carbamide coordinate with thorium through oxygen. Hypotheses were made on the structure of the carbamide-containing compounds of Th. The following coordination formulas for the compounds synthesized were proposed: $\{Th[OC(NH_2)_2]_8\}L_m$; $\{Th[OC(NH_2)_2]_6L_{(4-m)}(H_2O)_n\}L_m$;

$\{Th[OC(NH_2)_2]_4L_{(4-m)}(H_2O)_n\}L_m$; where L = Cl^-, Br^-, I^-, NO_3^-, NCS^-, $HCOO^-$. (tr-auth)

42932 INFRARED ABSORPTION SPECTRA OF VANADIUM, NIOBIUM, AND TANTALUM CARBIDES AND LOWER OXIDES. Alyamovskii, S. I.; Shveikin, G. P.; Gel'd, P. V. Zh. Neorg. Khim., 12: 1738-42(July 1967). (In Russian).

The ir absorption spectra of carbides and lower oxides of V, Nb, and Ta were obtained. It was shown that the position of the absorption band (1070 to 1100 cm^{-1}), responsible for the oscillation in the Me–O and Me–C bonds, is practically independent of the nature of the cation and of the phase state and lattice parameters. It was hypothesized that the general character of the spectra of the compounds examined is connected with the presence in the compounds of elementary nuclei of metalloid atoms (and vacancies), occurring in the next octahedric group of the metal atoms. (tr-auth)

42933 HYDROGEN–DEUTERIUM EQUILIBRATION AND ORTHO–PARAHYDROGEN CONVERSION ON MOLECULAR SIEVES. Turkevich, J.; Ciborowski, S. (Princeton Univ., N. J.). Contract AT(30-1)-1158. J. Phys. Chem., 71: 3208-17(Sept. 1967). (NYO–1158-15).

An investigation was made of the o-p-hydrogen conversion and H_2-D_2 equilibrium on a number of faujasite-type molecular sieves in order to determine the nature of catalytic centers. For this purpose a simple method of preparing a faujasite was developed to produce material that would supplement the available commercial product. The conversion of the Na faujasite to the NH_4, H_2, and decationated faujasite was studied. A gas chromatographic analysis was developed for the various H species. A correlation previously found between extent of Na replacement and catalytic activity for H_2D_2 equilibration was extended to the degree of conversion of H faujasite to decationated faujasite. The o-p-hydrogen conversion was found to be independent of the degree of decationization and must be ascribed to small traces of paramagnetic impurities, or to the effect of the nuclear magnetic moment of Al. The effect of γ irradiation was also studied. (auth)

42934 TWO SPIN TEMPERATURES IN A SOLID WITH CRYSTALLOGRAPHICALLY NONEQUIVALENT LIKE SPINS. Kydon, D. W.; Petch, H. E.; Pintar, M. (McMaster Univ., Hamilton, Ont.). Phys. Lett., 25A: 360-1(Sept. 11, 1967).

The deuterons of the crystallographically nonequivalent ND_4 groups in $(ND_4)_2SO_4$ form two subsystems with independent spin–lattice relaxation times which, between −60 and −120°C, are smaller than the intersystem spin diffusion time. After a disturbance, each subsystem quickly establishes semi-equilibrium at its own spin temperature and approaches thermal equilibrium with the lattice at a rate determined by its own relaxation time. (auth)

42935 THE ACID-BASE-CATALYZED HYDRATION OF ACETALDEHYDE. BUFFER AND METAL ION CATALYSIS. Pocker, Y.; Meany, J. E. (Univ. of Washington, Seattle). J. Phys. Chem., 71: 3113-20(Sept. 1967).

The capacity of the acid-base components of diethylmalonate, phosphate, and imidazole buffers to catalyze the reversible hydration of acetaldehyde at 0.0°C was determined using a spectrophotometric method. It was observed that in imidazole buffers an acetaldehyde-imidazole complex is produced appreciably faster than the hydration, so much so that the rates of hydration are determined after the initial equilibrium between free acetaldehyde, free imidazole, and acetaldehyde-imidazole complex is established: $K = [Ac \cdot Im]/\{[Ac]-[Im]\} \simeq 0.13$ l $mole^{-1}$. The hydration data show that although catalysis by imidazole and by the dianion of diethylmalonic acid is moderate, that due to monohydrogen phosphate dianion is significantly larger even though the pK_a values of the respective conjugate acids associated with these bases are similar. Parallel conclusions apply to dihydrogen phosphate, which is a more potent hydration catalyst than either imidazolium ion or the monoanion of diethylmalonic acid. The use of buffers also enabled the accurate determination of k_{OH^-} as 6.8×10^5 l $mole^{-1}$ min^{-1}. The catalytic efficiency of HPO_4^{2-} vs imidazole for the hydration of acetaldehyde is shown to parallel that observed for the reversible hydration of carbon dioxide. The solvent deuterium isotope effects associated with several general acids and bases in the reversible hydration of acetaldehyde are very similar to those observed in the mutarotation of glucose. Zinc ion catalysis was studied in relation to that derived from the Zn metallo enzyme carbonic anhydrase. While the catalysis afforded by Zn ions in acetate buffers (pH 6.69) or in malonate buffers (pH 7.5) is mild, enhanced catalysis is observed when Zn ions are introduced into imidazole buffers (pH 7.63). (auth)

42936 THEORETICAL CALCULATION OF KINETIC ISOTOPE EFFECTS. EFFECT OF REACTION COORDINATE VARIATIONS ON THE TEMPERATURE-INDEPENDENT FACTOR, TIF. Buddenbaum, Warren E.; Yankwich, Peter E. (Univ. of Illinois, Urbana). Contract AT(11-1)-1142. J. Phys. Chem., 71: 3136-43(Sept. 1967). (COO–1142-70).

A general method is developed for forcing a model-activated complex of arbitrary complexity to have a preselected imaginary (or zero) frequency corresponding to a preselected vibrational motion. Techniques already available in the literature are shown to be special cases of the method. Comparisons are made between the Slater coordinate and the reaction coordinate of the transition-state theory, and an expression is developed for the mass dependence of the latter. An equation also is given for the ab initio calculation in terms of Slater coordinate coefficient of the high-temperature limit (TIF) of the kinetic isotope effect, ν_l/ν_l'. (auth)

42937 APPLICATION OF THE STATISTICAL THEORY OF MASS SPECTRA TO THE DECOMPOSITION OF $C_2H_6^+$ AND $C_2D_6^+$[a,b]. Prasil, Z.; Forst, W. (Univ. Laval, Quebec). J. Phys. Chem., 71: 3166-77(Sept. 1967).

In an effort to obtain a meaningful test of the statistical theory of mass spectra, breakdown curves were calculated for decomposition of excited $C_2H_6^+$ and $C_2D_6^+$ and compared with experimental curves obtained in charge-transfer experiments. This procedure obviates any assumption about the energy distribution function, which would be necessary for the calculation of actual mass spectra. The Marcus–Rice formulation was used for unimolecular rate constants, and anharmonic vibration–rotation energy sums were calculated on a computer. All important parameters for the molecular ions and their complexes are taken, when available, from their respective neutral counterparts and the corresponding thermal reactions. In the case of the complexes, the average Morse dissociation energy, D, which determines the anharmonic correction, cannot be readily estimated and is used as an adjustable parameter to obtain the best fit between theory and experiment. Good agreement is obtained between the two for reasonable values of D for first-generation fragment ions. Fluctuation of energy is considered in calculating breakdown curves for second-generation ions, and good agreement between theory and experiment is likewise obtained. While this agreement does not furnish proof either for or against the assumption that electronic excitation energy is converted into internal energy of the ground-state ion, it does indicate that at least in the present case the other assumptions made in the theory are successful. (auth)

42938 SOLUBILITIES OF HYDROGEN FLUORIDE AND DEUTERIUM FLUORIDE IN MOLTEN FLUORIDES. Field, Paul E. (Virginia Polytechnic Inst., Blacksburg); Shaffer, James H. J. Phys. Chem., 71: 3218-22(Sept. 1967).

The solubilities of HF and DF in molten $LiF-BeF_2$ (66–34 mole %) were determined over the temperature range 500 to 700°C and at solute gas pressures between 1 and 2 atm. Using previously established experimental methods, the solubilities of both gases were found to obey Henry's law. The Henry's law constants, K_H (10^{-4} mole of HF/mole of melt-atm) for HF and DF, respectively, at 500, 600, and 700°C were: 3.37 ± 0.13, 2.96 ± 0.07; 2.16 ± 0.05, 1.83 ± 0.03; 1.51 ± 0.06; 1.25 ± 0.03; where the values given were obtained by a linear least-squares fit of the experimental data as $\ln K_H$ vs 1/T and the uncertainties are at the 95% confidence interval. The heats of solution, ΔH^s, obtained from the least-squares evaluation were −5.98 ± 0.19 and −6.43 ± 0.15 kcal/mole for HF and DF, respectively. The comparison of ΔH^s for HF in this melt composition with those obtained previously in melts ranging from 54 to 89 mole % LiF in BeF_2 reveals linear dependence of ΔH^s on the mole fraction of LiF above and below 67% with a maximum of 67% LiF. Interpretation of the isotope effect was made by comparison of the difference in the entropies of solution between DF and HF with the difference in the calculated values of the entropies of the two gases at 600°C. (auth)

42939 ISOTOPE EFFECTS ON VAPORIZATION FROM THE ADSORBED STATE. THE METHANE SYSTEM. Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). J. Phys. Chem., 71: 3270-5(Sept. 1967).

It is pointed out that the statistical theory of isotope effects in condensed systems is applicable to isotope effects on adsorption. The appropriate theoretical equations and approximations to them are discussed. Adsorption isotope effects for the methane "wet glass" system are treated in detail as an example. Consistency with the theory is demonstrated, and it is concluded that at least for this system rotation on the surface is strongly hindered and that it is not necessary to invoke different interaction potentials with the surface for different isotopically substituted molecules. (auth)

42940 GAS CHROMATOGRAPHY OF PERDEUTERIOMETHANE. ISOTOPE EFFECT ON ADSORPTION ON POROUS GLASS. Phillips, James T.; Van Hook, W. Alexander (Univ. of Tennessee, Knoxville). J. Phys. Chem., 71: 3276-9(Sept. 1967).

The separation factor for CH_4-CD_4 on dry porous glass was

measured between room temperature and −170°C. The isotope effect was inverse and approximately linear in 1/T. A significant lowering of the isotope effect was observed when the surface was poisoned with water. The results are discussed in the context of the statistical theory of isotope effects in condensed systems and consistency with the theory is demonstrated. (auth)

42941 ^{13}C SATELLITE INTERFERENCE WITH CHEMICAL SHIFT MEASUREMENTS IN CYCLOHEXANE–DIETHYLAMINE SOLUTIONS. Murphy, Ruth Ann (Univ. of Texas, Austin); Davis, Jeff C. Jr. J. Phys. Chem., 71: 3361-2(Sept, 1967).

Data and detailed explanations are presented for the ^{13}C-satellite interference with chemical shift in cyclohexane-diethylamine solutions. The NMR data were obtained at 31°C and are tabulated. This same variation of shift of the NH proton of piperidine was noted as a function of concentration in cyclohexane. (B.L.M.)

42942 MICROWAVE SPECTRUM, STRUCTURE, AND DIPOLE MOMENT OF FLUOROTRICHLOROSILANE. Holm, R.; Mitzlaff, M.; Hartmann, H. (Univ., Frankfurt am Main). Z. Naturforsch., 22a: 1287-9(Aug. 1967). (In German).

The microwave spectrum of $SiFCl_3$ was investigated in the region from 8 to 40 Gc and from the rotational constants the following structural parameters were obtained using an approximation method: $d_{SiF} = 1.520$ Å, $d_{SiCl} = 2.019$ Å, ∢FSiCl = 109.55°. From the Stark effect pattern of the transition J = 5 → 6 the dipole moment $\mu = 0.49$ D was determined. (auth)

42943 MICROWAVE SPECTROSCOPIC INVESTIGATIONS ON METHYL MERCURY IODIDE. Feige, C.; Hartmann, H. (Univ., Frankfurt am Main). Z. Naturforsch., 22a: 1286-7 (Aug. 1967). (In German).

The microwave spectrum of CH_3HgI with five different isotopes of mercury was investigated in the region of 8 to 42 Gc/s. The quadrupole coupling of ^{127}I was determined. The rotational constants of CH_3HgI with the isotopes ^{196}Hg, ^{199}Hg, ^{200}Hg, ^{202}Hg, and ^{204}Hg were derived from the resolution of the hyperfine structure. The bond lengths were calculated. The dipole moment of the molecule was determined from the investigation of the Stark effect. (auth)

42944 URANYL CARBAMIDE OXALATE COMPOUNDS OF THE TETRAACID TYPE. Shchelokov, R. N.; Belomestnykh, V. I. Zh. Neorg. Khim., 12: 1603-14(1967). (In Russian).

New methods for the synthesis of mixed uranyl carbamido oxalate of ammonia, guanidine, and potassium are proposed; sodium, rubidium, cesium, ethylenediammonia, and aniline derivatives of uranyl carbamido oxalate ions were synthesized for the first time. Some physico-chemical properties of the isolated compounds were investigated. It was found that the replacement reactions, leading to their formation, are reversible and depend both on the concentration conditions and on the nature of the external sphere of the cation. It was established that carbamide is capable of replacing not only hydrate but noncyclic bonds of the oxalate groups in uranyl oxalate compounds. The dismutation of uranyl carbamido oxalate ions under the effect of carbamide was detected on aniline derivatives. The structure of the uranyl carbamido oxalate was considered and it was indicated that uranyl compounds of the dioxalate series —pentacoordination compounds exist. (tr-auth)

42945 DISTRIBUTION OF Gd, Tb, Dy, Ho, AND Y IN A TRIBUTYL PHOSPHATE–NITRIC ACID SYSTEM. Mikhlin, E. B.; Korpusov, G. V. Zh. Neorg. Khim., 12: 1633-8(1967). (In Russian).

Data on the distribution of individual elements of the yttrium subgroup, Gd, Tb, Dy, Ho, and Y, in the TBP–HNO_3 system were obtained at HNO_3 concentrations from 8 to 14 mol. It was found that in the distribution of rare earth elements in the TBP–HNO_3 system the Y is extracted better than Ho and the other elements of the middle portion of the rare earth group. The mean value of the partition coefficients of Y and Gd is 2.5 and increases with decrease of the Y content in the original mixture. (tr-auth)

42946 THE REDUCTION OF COBALT(III) BY NEPTUNIUM(V) AND THE NEPTUNIUM(V)–CHROMIUM(III) COMPLEX. Sullivan, James C.; Thompson, Richard C. (Argonne National Lab., Ill.). Inorg. Chem., 6: 1795-8(Oct. 1967).

The rate law for the reaction Np(V) + Co(III) = Np(VI) + Co(II), from 5 to 25° in perchloric acid–lithium perchlorate solutions of constant ionic strength, is $-d[Np(V)]/dt = k'[Np(V)][Co(III)]$ where $k' = k_0e^{-\beta(H^+)}$. Under the same conditions, the rate law for the reaction Co(III) + Np(V) · Cr(III) = Co(II) + Np(VI) + Cr(III) is $-d[Np(V) \cdot Cr(III)]/dt = k'_c[Np(V) \cdot Cr(III)][Co(III)]$ where $k'_c = k''_c[H^+]^{-1}e^{-\beta'(H^+)}$. Presumably the exponential factor in each of these rate laws is caused by mild medium effects. (auth)

42947 SPIN-LATTICE RELAXATION AND PHASE TRANSITION IN DEUTERATED AMMONIUM BROMIDE. Woessner, D. E.; Snowden, B. S. Jr. (Mobil Oil Corp., Dallas). J. Chem. Phys., 47: 2361-3(Oct. 1, 1967).

The low-temperature order–order transition is deuterated ammonium bromide was studied. In a 99% deuterated sample of ammonium bromide, a hysteresis effect was observed. The T_1 minimum value obtained with a decreasing temperature sequence appeared 0.06 msec higher than the value of 0.45 msec obtained with an increasing temperature sequence. With a 94% deuterated sample of ammonium bromide, no such hysteresis effect was observed. Assuming that the activation energy is a function only of lattice type, it is possible to explain this behavior in 99% ND_4Br in terms of the coexistence of two phases in the temperature range between 163 and 169°K. (auth)

42948 FAR-INFRARED TORSIONAL VIBRATION SPECTRUM OF CD_3CD_2Cl. Moller, K. D.; London, L. H. (Fairleigh Dickinson Univ., Teaneck, N. J.). J. Chem. Phys., 47: 2505-6(Oct. 1, 1967).

The far-infrared absorption spectra of deuterated chloroethane was investigated using a vacuum-grating spectrometer and compared with that for nondeuterated. A simple one-degree-of-freedom model was used to evaluate potential height to internal rotation. (M.C.G.)

42949 FURTHER APPLICATIONS OF THE DOMAIN THEORY OF LIQUID WATER. I. SURFACE TENSION OF LIGHT AND HEAVY WATER. II. DIELECTRIC CONSTANT OF LOWER ALIPHATIC ALCOHOLS. Jhon, Mu Shik (Univ. of Virginia, Charlottesville); Van Artsdalen, E. R.; Grosh, Joseph; Eyring, Henry. J. Chem. Phys., 47: 2231-4(Oct. 1, 1967).

Recently, Jhon, Grosh, Ree, and Eyring used the significant-structure theory to explain all the thermodynamic and transport properties of water, assuming that it contains domains of about 46 molecules that change their structure as a unit from an "ice I-like" to an "ice III-like" state. Following this, Hobbs, Jhon, and Eyring explained the dielectric constant of liquid water. According to their theory, an applied field will make those domains grow that are favorably oriented with respect to the field at the expense of the less favorably oriented until a steady state is achieved. This domain theory of liquid water was applied to several cases. Surface tension of liquid water was successfully calculated in good agreement with experiment applying the generalized method of Chang et al. Assumptions were made that the molecules in the top layers are in an asymmetric field and tend to orient in the direction of the field. This leads to continuous changes in the density for the various layers. The calculation of the dielectric constant of various alcohols was carried out by a similar scheme to that used for liquid water, and the effect of the G factor in the formula is discussed. (auth)

42950 CRYSTAL STRUCTURES AND LATTICE PARAMETERS OF THE COMPOUNDS OF BERKELIUM. I. BERKELIUM DIOXIDE AND CUBIC BERKELIUM SESQUIOXIDE. Peterson, J. R.; Cunningham, B. B. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 3: 327-36(Sept. 1967).

Details are given of the preparation of these oxides from ^{249}Bk, together with methods of purification. The "dioxide" was prepared directly from a Bk-loaded ion exchange resin bead by calcination in air at 1200°C. Hydrogen reduction of the dioxide at 600°C led to formation of the body-centered cubic Mn_2O_3-type sesquioxide. Reoxidation in air or oxygen at 600°C then rapidly converted the sesquioxide back to dioxide. Due to the rapid growth of ^{249}Cf into the ^{249}Bk samples all the compounds prepared contained varying amounts of ^{249}Cf, but in all cases the ^{249}Bk content was ≥95 at. %. All samples were examined by standard x-ray powder techniques. Following indexing, the observed Bragg angles were computer processed to determine the most probable lattice parameter. Theoretical line intensities were calculated by means of the POWD program developed by D. K. Smith (UCRL Report 7196). The $(Fe,Mn)_2O_3$, bixbyite, structure was assumed for Bk_2O_3, and the fluorite structure for BkO_2. All lines could be indexed on these assumed structures and agreement between observed and calculated line intensities was considered satisfactory. Observed lattice parameters are tabulated, together with the line list and indexing for a representative BkO_2 pattern, the observed and calculated 2θ values, and the observed and calculated line intensities. Also tabulated are the partial line list and indexing for a sample of Bk_2O_3. Plots are included of the cubic lattice parameters for the actinide "dioxides" and lanthanide and actinide Mn_2O_3-type sesquioxides. Some data are given for ionic radii. It was noted that for the dioxides the cubic parameter increased with time, apparently corresponding to formation of Cf^{3+} ions; the opposite was evident for the sesquioxides since Cf^{3+} is smaller than Bk^{3+}. (UK)

42951 CRYSTALLOGRAPHY OF THE COMPOUNDS OF CALIFORNIUM. I. CRYSTAL STRUCTURE AND LATTICE PARAMETERS OF CALIFORNIUM SESQUIOXIDE AND CALI-

FORNIUM TRICHLORIDE. Green, J. O.; Cunningham, B. B. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 3: 343-9(Sept. 1967).

Details are given of the purification of the ^{249}Cf used in these studies, and of the preparation of the oxide and trichloride. The oxide was prepared by ignition of Cf-loaded ion exchange resin beads at ~1200°C, followed by treatment with dry hydrogen at 600°C. Conversion of the oxide to trichloride was accomplished by treatment with anhydrous HCl at 520°C. Samples were examined by standard x-ray powder techniques. The patterns were indexed by comparison with data available on isostructural compounds and by use of $\sin^2\theta$ data and intensity calculations performed according to the POWD computer program developed by D. K. Smith (UCRL Report 7196). Lattice parameters are tabulated, together with partial line lists and indexing, for the monoclinic sesquioxide, and the latter for the hexagonal trichloride. Least squares lattice parameters for two trichloride samples were $\underline{a}$ = 7.390 Å, $\underline{c}$ = 4.095 Å, and $\underline{a}$ = 7.396 Å, $\underline{c}$ = 4.085 Å. The ionic radius of Cf^{3+} was calculated as 0.976 Å. Analogies are drawn between these Cf compounds and the corresponding rare earths. (UK)

42952 ISOTOPE EFFECT IN ISOTOPIC EXCHANGE BETWEEN NICKEL IONS AND A NICKEL CHELATE COMPLEX. Elias, H. (Technische Hochschule, Darmstadt, Ger.). Radiochim. Acta, 7: 192-5(Aug. 1967). (In German).

The isotopic exchange reaction, $[Ni(en')_2]^{2+} + {}^*Ni^{2+} \underset{k'}{\overset{k}{\rightleftharpoons}} [{}^*Ni(en')_2]^{2+} + Ni^{2+}$, (en' = tetramethylethylene diamine), was studied at 45°C using the radioisotopes $^*Ni = {}^{57}Ni$ and $^*Ni = {}^{65}Ni$. From the activity distribution in the exchange equilibrium, the equilibrium constants were calculated to $K = k/k' = 0.9937 \pm 0.0018$ (^{57}Ni) and $K = 1.0061 \pm 0.0022$ (^{65}Ni). The value for the kinetic isotope effect of the back reaction was found to be $k'(^{57}Ni)/k'(^{65}Ni) = 1.0125 \pm 0.0029$. (auth)

42953 REACTIONS OF SODIUM CHLORIDE WITH DYSPROSIUM AND GADOLINIUM CHLORIDES. Orlov, K. V.; Kozlov, V. G.; Pospelova, N. G. pp 73-6 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Component reactions of $NaCl-GdCl_3$ and $NaCl-DyCl_3$ were analyzed. Incongruently melting compounds Na_3CdCl_6 were found in the $NaCl-GdCl$ system at 500°C. In the $NaCl-DyCl_3$ system at 430 ± 5°C compounds were observed which are described by $NaDyCl_4$ formula, and Na_2DyCl_5 at 500 ± 2°C. Calculations of the liquidus lines indicate the presence of complex ions $(CdCl_6)^{3-}$; $(DyCl_4)^-$; and $(DyCl_5)^{2-}$.. (R.V.J.)

42954 SELF-DIFFUSION IN α URANIUM. Fedorov, G. B.; Smirnov, E. A.; Zhomov, F. I. pp 92-8 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The boundary and volume diffusion parameters of uranium α-phase self-diffusion were measured. It was found that the level of migrating diffusion at the grain boundaries is much higher (by the order of 4 or 5) than the volume diffusion. The self-diffusion coefficients as function of temperature are expressed as: $D_{vol} = 4.5 \times 10^{-4}$ exp (−42,200 RT) cm^3/sec, and $D^{\delta}_{boundary} = 1.6 \times 10^{-3}$ exp (−44,300/RT) cm^3/sec. (R.V.J.)

42955 ABSORPTION METHOD FOR DETERMINING DIFFUSION COEFFICIENTS OF α-RADIOACTIVE ELEMENTS. Pavlinov, L. V.; Nakonechnikov, A. I. pp 124-9 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

A simple absorption method is used for determining the diffusion ability of α-radioactive elements. With $\alpha^2/4\ Dt \ll 1$ the equation is expressed as: $D = \alpha^2/\pi t\ (I_0/I)^2$. Experiments with U diffusion in β-Ti carried out by absorption method and by layer analysis were in good agreement. The temperature dependence of U diffusion in β-Ti is expressed by an equation: $D = 5.1 \times 10^{-4}$ exp (−29,300/RT) cm^3/sec. (tr-auth)

42956 MELT DIAGRAM FOR A MIXTURE OF RARE EARTH ELEMENTS AND SODIUM CHLORIDE. Orlov, K. V.; Kozlov, V. G.; Pospelova, N. G. pp 215-18 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Differential-thermal analysis was made of the $\Sigma RECl_3-NaCl$ system (where RE is cerium group mixture). It was found that $\Sigma RECl_3-NaCl$ system melts according to a simple eutectic scheme; the eutectic composition was 35.5 mol% $\Sigma RECl_3$ (70 wt %) at 488°C. (tr-auth)

42957 HEAT OF COMBUSTION OF PLUTONIUM NITRIDE. Lapage, Ruth; Bunce, J. L. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Trans. Faraday Soc., 63: 1889-94(Aug. 1967).

Plutonium nitride was prepared by the reaction of nitrogen with plutonium hydride at 400 to 500°C. The heat of combustion in oxygen was measured and from this the heat of formation, −70.2 ± 1.5 kcal/mole, was calculated. (auth) (UK)

42958 INVESTIGATION OF INORGANIC SYSTEMS AT HIGH TEMPERATURE BY MASS SPECTROMETRY. Drowart, J.; Goldfinger, P. (Univ. Libre, Brussels). Angew. Chem. Int. Ed. Engl., 6: 581-96(July 1967).

An investigation of many oxides, halides, and carbon molecules and intermetallic molecules was made using high-temperature mass spectrometry. An apparatus for the production and investigation of molecular beams is described. Knudsen cells permit the production of molecular beams under equilibrium conditions; in special cases the "double-oven" type of Knudsen cell is used. Thermodynamic and kinetic quantities such as ΔH^0_T values, dissociation energies, and ionization cross sections of the species investigated are given. (150 references) (auth)

42959 ELECTRONIC ABSORPTION SPECTRA OF GASEOUS $PuCl_3$, $PuBr_3$, AND $PuCl_4$. THE THERMODYNAMICS OF $PuCl_4$. Gruen, D. M.; DeKock, C. W. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 2569-75(Oct. 1967).

The electronic absorption spectra of gaseous $PuCl_3$, $PuBr_3$ and $PuCl_4$ were measured in the range from 4000 to 30,000 cm^{-1} at temperatures of ~1000°C. Intraconfigurational $5f^n \rightarrow 5f^n$ transitions and interconfigurational $5f^n \rightarrow 5f^{n-1}6d$ transitions were identified. The thermodynamics of the reaction $PuCl_3(l) + \frac{1}{2}Cl_2(g) \rightleftharpoons PuCl_4(g)$ were studied spectroscopically. The molar free energy change of this reaction is represented by the equation $\Delta F = 23{,}000 - 14.1T$ (cal). (auth) (UK)

42960 ACTINIDE CHELATES: URANIUM(IV) N,N-DIETHYLDITHIOCARBAMATE. Bagnall, K. W.; Holah, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 215: 623- (Aug. 5, 1967).

A preliminary study on the first observed U(IV) complex with a sulphur chelate is described. The pure compound was prepared by reacting stoichiometric quantities of UCl_4 with the sodium salt of DTC in dry ethanol in an inert atmosphere. The ethanol was removed quickly under vacuum at room temperature and the product recrystallized from dry benzene as yellow, air-sensitive plates, stable when stored in argon. Addition of ether or isopentane to the benzene solution increased the yield of the $U[S_2CN(C_2H_5)_2]_4$ to almost quantitative amounts. The complex decomposed when left in contact with alcohol, and solutions in benzene or methylene chloride were very sensitive to traces of oxygen. It appears likely that in this complex the U-atom is 8-coordinated to S. X-ray diffraction analysis was carried out, indicating a monoclinic system with $\underline{a}$ = 19.05, $\underline{b}$ = 11.67, $\underline{c}$ = 16.03 Å, β = 63° 35'. The density appeared to be between 2 and 3, and therefore the cell probably contains 6 molecules. The probable space group appears to be C2/m (C^3_2h). Further studies on this complex, and analogous tetravalent actinide complexes, are being undertaken. The studies are also being extended to include other sulphur, nitrogen, and oxygen chelates. (UK)

42961 THE REACTION OF GASEOUS BROMINE PENTAFLUORIDE WITH URANIUM COMPOUNDS. I. THE KINETICS OF THE REACTIONS WITH UF_4 AND UO_2F_2. Jarry, R. L.; Steindler, M. J. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 1591-7(July 1967).

Kinetics of the gas−solid reactions between BrF_5 and UF_4 and UO_2F_2 were studied in the temperature range 175 to 300°C and in the BrF_5 partial pressure range of 130 to 370 torr. Both of these reactions produce UF_6 as the main product, and in the case of the UF_4-BrF_5 reaction the intermediate uranium fluorides (U_2F_9, U_4F_{17}, and UF_5) as minor products. Analysis of the reaction products of the UF_4-BrF_5 reaction showed elemental bromine to be the other gaseous product of that reaction. The data were correlated using the diminishing sphere model, which describes the gas−solid reaction occurring at a continuously diminishing spherical interface. Activation energies of 16.9 and 8.3 kcal/mole, and order of pressures dependence values of 0.38 and 0.71, were calculated for the reactions with UF_4 and UO_2F_2, respectively. The following equations were derived to represent the temperature and BrF_5 partial pressure dependence of these two reactions: UF_4-BrF_5: $\log k' = 0.38 \log P_{BrF_5}$ (torr) − 3690/T(°K) + 4.286 and $UO_2F_2-BrF_5$: $\log k' = 0.71 \log P_{BrF_5}$ (torr) − 1810/T(°K). (auth) (UK)

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Refer also to abstracts 42933 and 43454.

42962 . (CONF-670542-1) TRANSURANIUM ELEMENTS AS BYPRODUCTS OF NUCLEAR FUEL REPROCESSING. Overbeck, W. P. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). May 1967. Contract AT(07-2)-1. 16p. Dep. CFSTI.

From Conference on Nuclear Power Fuel Reprocessing: Technology and Economics, Augusta, Ga.

The transuranium isotopes of principal interest are ^{238}Pu, ^{244}Cm, and ^{252}Cf. Substantial quantities of these isotopes can be obtained as by products of the nuclear power industry if the necessary recovery facilities are provided. These quantities can be considerably enhanced through recycling of uranium and plutonium fuels. Within the next 10 years, large-scale production of ^{238}Pu and ^{244}Cm could be achieved. If an adequate market can be developed, production of these transuranium isotopes could result in significant long-term savings in the cost of nuclear power. (auth)

42963 (JUL-77-RB) RADIOAKTIVE MARKIERUNGEN IM ELEKTRONENMIKROSKOP. (Radioactive Labeling in the Electron Microscope). Riedel, G. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). June 1965. 20p. (In German). Dep.

Three articles on radioactive labeling in the electron microscope are compiled. Preparation of an aerosol labeled with a radioisotope for use in the electron microscope is described. A means for electron-microscopic differentiation of emulsions of diverse origins exposed to α and β irradiation is reported. Improvement of the resolution of radioactive labeling by stereoscopic picture taking in the electron microscope is described and illustrated by stereoscopic pictures. (J.S.R.)

42964 (NYO-844-71) NUCLEAR CHEMISTRY AND GEOCHEMISTRY RESEARCH, CARNEGIE INSTITUTE OF TECHNOLOGY, 1966-1967. Progress Report. (Carnegie Inst. of Tech., Pittsburgh, Pa. Dept. of Chemistry). June 30, 1967. Contracts AT(30-1)-844; AT(30-1)-3624. 74p. Dep. CFSTI.

Research progress is reported on: Moessbauer spectroscopy of Fe in coal, terrestrial occurrence and distribution of ^{129}I, μ^--induced nuclear reactions in natural materials, activation analysis of iron meteorites, isotopic composition of thallium in meteorites, plans for radiogenic isotope studies of lunar materials, expectation levels of ^{129}I in meteorites, search for radioactivity of ^{48}Ca, counting systems, and cylindrical anticoincidence guard counter. (M.C.G.)

42965 (ORO-2418-3) INFRARED SPECTRA OF PLASTICS AND ELASTOMERS AFTER NUCLEAR IRRADIATION. Annual Progress Report. Sears, W. C. (Georgia Univ., Athens. Dept. of Physics). Sept. 12, 1967. Contract AT(40-1)-2418. 13p. Dep. CFSTI.

Since molar absorptivity for the trans-vinylene band in trans-1, 4-polybutadiene was found to change with temperature, a study of it has begun to determine applicable absorptivities for analyzing irradiated polymers whose spectra have been measured at elevated temperatures to eliminate crystallinity. It has been found that molar absorptivity drops sharply at 46°C in changing from crystalline modification I to II. There is a possibility that this transition temperature will shift to 76°C after being cooled from above 76°C or to melt at 145°C to room temperature. Applicable trans-vinylene absorptivities for analyzing irradiated Neoprenes may be evaluated from the Neoprene polymers themselves or from values obtained from trans-1,4-polybutadiene. A study is also in progress on the effects of gamma rays on poly-2-vinyl pyridine and a 75/25 copolymer of 1,3-butadiene and 2-methyl-5-vinylpyridine. (auth)

42966 (NP-tr-1565) WOOD-PLASTIC COMPOSITE, WPC. Miettinen, J. K. Translated from Kem. Teollisuus, 23: 1084-8(1966). 8p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Studies were made of the production of wood-plastic combinations by impregnating wood blocks with monomers and irradiating them. Bending strength of the wood was increased, shearing strength increased, and water absorption decreased. Dimensional changes in the wood were greatly reduced. Uses of the wood-plastic combinations are discussed. (M.C.G.)

42967 THE RADIATION CHEMISTRY OF CYCLIC DIENES. II. THE RADIOLYSIS OF 1,4-CYCLOHEXADIENE IN THE GAS PHASE. Nakagawa, Tsunehiko; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap., 40: 2081-5 (Sept. 1967).

The γ radiolysis of 1,4-cyclohexadiene vapor was investigated at room temperature. The gaseous products were hydrogen, acetylene, and 1,3-butadiene. Benzene, cyclohexene, 1,3-cyclohexadiene, and 1,3,5-hexatriene were identified as the low volatile liquid products. The yield of each product was almost independent of the dose (0.87 to 9.11) $\times 10^{19}$ eV, while it was remarkably dependent on the gas pressure (8 to 56 mm Hg). The G-values of hydrogen, the $C_3 + C_4$ gas fraction, benzene, and cyclohexene were 1.95, 1.25, 28.5, and 14.0, respectively at 42 mm Hg. The large yields of benzene and cyclohexene may be explained in terms of a chain mechanism. The pressure dependence of these products was very similar in both the Hg-sensitized photolysis and the γ radiolysis of this diene vapor. The presence of the long-lifetime intermediates was as expected. The experiments with nitric oxide added as a radical scavenger suggest that the main path of hydrogen formation is the radical process. (auth)

42968 RADIOLYSIS OF Co^{III}-EDTA IN AQUEOUS SOLUTION; THE YIELDS OF HYDROGEN AND HYDROGEN PEROXIDE IN 0.8N SULFURIC ACID. Matsuura, Niro (Tokyo Univ.); Shinohara, Nobuyoshi; Nishikawa, Masaru; Takizawa, Masao. Bull. Chem. Soc. Jap., 40: 2042-7(Sept. 1967).

The hydrogen and hydrogen peroxide produced in the radiolysis of Co^{III}-EDTA ($Co^{III}Y^-$) in 0.8 N sulfuric acid were measured. The yields of hydrogen and hydrogen peroxide were found to be $G_\infty(H_2) = 0.4$ and $G_\infty(H_2O_2) = 2.5$ for the aerated system, $G_\infty(H_2) = 3.2$ and $G_\infty(H_2O_2) = 0$ for the deaerated system were G_∞ denotes the yield. at the infinite solute concentration. The decomposition mechanism proposed previously was discussed in detail on the basis of the observed $G_\infty(H_2)$ and $G_\infty(H_2O_2)$ and of the effect of chloride ion on the decomposition yield $G_\infty(-Co^{III}Y^-)$. A similar experiment was carried out for EDTA alone and the decomposition mechanism is discussed. (auth)

42969 ION-MOLECULE REACTIONS IN THE RADIOLYSIS OF ORGANIC LIQUIDS. Ward, James A.; Hamill, William H. (Univ. of Notre Dame, Ind.). J. Amer. Chem. Soc., 89: 5116-20(Sept. 27, 1967).

Conventional carbonium ion reaction mechanisms provide a basis for measuring yields of carbonium ions in suitable radiolytic systems, e.g., hydrocarbon-alcohol liquid mixtures. Small yields of products expected from carbonium ions were found: anisole from benzene-methanol; cyclohexyl ethyl ether from cyclohexane-ethanol; t-butyl ethyl ether from neopentane-ethanol; ethyl acetate from acetone-ethanol, all at ca. 20°C. Complicating ion-molecular processes may include proton transfer from $c\text{-}C_6H_{11}^+$ and $t\text{-}C_4H_9^+$ to C_2H_5OH as well as competition between $RH^+ \rightarrow R^+ + H$ and $RH^+ + R'OH \rightarrow R\cdot + R'OH_2^+$. There is evidence for proton transfer from $c\text{-}C_6H_{12}^+$ to ethanol, but not from $neo\text{-}C_5H_{12}^+$. The structure of the parent molecule had a marked effect on yields with G(carbonium ion) ranging from ~0.03 for benzene to greater than 1.2 for neopentane. (auth)

42970 POSITRON ANNIHILATION IN RADIATION-INDUCED SOLID-STATE POLYMERIZATION. Ogata, Atsushi; Tabata, Yoneho; Hamaguchi, Hiroshi (Tokyo Univ.). Bull. Chem. Soc. Jap., 40: 2205(Sept. 1967).

Positron annihilation in the gamma-radioinduced, solid-state polymerization of acetaldehyde was studied. It was found that the positron lifetime spectrum was affected by both lattice deformation due to polymerization and accumulation of active species with irradiation. It is believed that the variation of positron lifetime spectra can give useful information about the mechanism of solid-state polymerization. (J.G.B.)

42971 GRAFT-COPOLYMERIZATION OF N-VINYLPHTHALIMIDE TO POLYETHYLENE BY γ-RAY RADIATION. Murata, Kenichi (Government Industrial Research Inst., Osaka). Bull. Chem. Soc. Jap., 40: 2187-9(Sept. 1967).

The γ radioinduced graft polymerization of N-vinylphthalimide to polyethylene was studied. The grafted film was reacted with n-propylamine at room temperature, and the process of the reaction traced by infrared spectra. Results of dyeing the grafted film as well as the amine-treated film with direct, acid, basic, and dispersed dyes are reported. The amine-treated films were dyed more easily than the original copolymer. (J.G.B.)

42972 HYDROGEN ISOTOPE EFFECTS IN THE RADIOLYSIS OF WATER. Vukmirovic, Zorka B. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Israel J. Chem., 5: 75-87(May-June 1967).

The tritium fractionation between water and radicals formed in the radiolysis of dilute solutions of monomerous methyl methacrylate in H_2O-HTO and D_2O-DTO mixtures was studied. A parallel determination of the tritium content in molecular hydrogen was performed. Also, the isotopic composition of the initial molecular hydrogen was measured in the concentration range 10 to 90 mole % D_2O of H_2O-HDO-D_2O mixtures. Hydrogen atoms, hydroxyl radicals, and molecular hydrogen produced in the radiolysis of these solvents were found to be depleted in heavier hydrogen isotopes. The isotope effects on the composition of hydrogen atoms are discussed in terms of the rate isotope effects in proton transfer. The isotope effects on the composition of hydroxyl radicals are close to

those on molecular hydrogen and their extent suggests ionic dissociation of water as a rate-determining step in the process of formation of both products. (auth)

42973 SEPARATION OF SOME RADIOACTIVE ISOTOPES FROM THE CYCLOTRON TARGETS. Sevast'yanov, Yu. G.; Bezmaternykh, A. S. (Physico-Energetic Inst., Obninsk, USSR). Chem. Zvesti, 21: 616-19(1967). (In Russian).

Methods for separation of carrier-free radioactive preparations from the bulk of the cyclotron target material are reported. Methods for isolation of carrier-free ^{22}Na, ^{26}Al, and ^{73}As and ^{74}As were developed. ^{22}Na was obtained in such a way that the magnesium target (alloy MA8) was irradiated with deuterons. Magnesium was activated and then precipitated to form magnesium sulfate; afterwards it was removed from the water-acetone solution. ^{22}Na was then retained on a cation exchanger from which it was desorbed with 0.1N HCl. ^{26}Al, which was formed in the course of the activation, was separated in the following way: it was precipitated as aluminum hydroxide with ammonia, this was transformed to soluble aluminate by means of NaOH, this was purified on anex, then it was sorbed on catex and desorbed with 2N HCl. Radioisotopes $^{73,74}As$ were prepared by irradiating germanium (Cu–Ge alloy) with deuterons and by their coprecipitation with iron hydroxide at pH 3.5 to 4.0. Separation from the iron and purification from germanium and ^{65}Zn was made by means of anion exchangers. These methods are suitable for separation of radioisotopes from industrial targets up to 100 g. (auth)

42974 THE EFFECT OF WATER ON HYDROGEN YIELDS IN THE γ RADIOLYSIS OF 1,4-DIOXANE. Hentz, Robert R.; Mellows, Frank W.; Sherman, Warren V. (Univ. of Notre Dame, Ind.). J. Phys. Chem., 71: 3365-6(Sept. 1967). (COO-38-560).

Since the radioinduced processes in 1,4-dioxane are so sensitive to the presence of water, a special purification procedure was developed and is described. The effects of varying concentrations of water on the γ radiolysis of dioxane are shown graphically. The enhancement of the apparent $G(H_2)$ caused by the presence of H_2O is explained in terms of a proton-transfer mechanism. (B.L.M.)

42975 PRODUCT INVENTORY OF THE RADIOLYSIS OF CRYSTALLINE CHOLINE CHLORIDE. Ackerman, Margaret; Lemmon, Richard M. (Univ. of California, Berkeley). J. Phys. Chem., 71: 3350-2(Sept. 1967).

The quantitative measurements of all detectable products was undertaken in an effort to elucidate the mechanism of the radiolysis of crystalline choline chloride. The samples were irradiated with γ rays from a ^{60}Co source. Hydrogen, methane, acetaldehyde, methyl chloride, trimethylamine, a polymer, and Cl_2 were identified as products. The various quantities of each product were found to be related to total dose. (B.L.M.)

42976 PULSE-RADIOLYSIS STUDY OF THE DEPENDENCE OF THE REACTION OF ATOMIC OXYGEN WITH OXYGEN ON THE NATURE OF THE THIRD BODY. Sauer, Myran C. Jr. (Argonne National Lab., Ill.). J. Phys. Chem., 71: 3311-13 (Sept. 1967).

The rate constant of the third-body (Ar)-controlled reaction of oxygen atoms with molecular oxygen was found to be independent of whether the oxygen atom originates from O_2, CO_2, or N_2O. The third-body effiifiencies of He, CO_2, and N_2O relative to an Ar efficiency of 1.0 were determined as 0.8, 5, and 5, respectively. (auth)

42977 SCAVENGER KINETICS IN THE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS. II. CYCLOHEXANE–METHYL IODIDE MIXTURES. Mani, Inder; Hanrahan, Robert J. (Univ. of Florida, Gainesville). Contract AT(40-1)-3106. J. Phys. Chem., 71: 3301-10(Sept. 1967). (ORO-3106-22).

The scavenging effects of added HI and I_2 in the radiolysis of cyclohexane–methyl iodide solutions were investigated. An interpretation of the results, which is similar to those made earlier for pure alkyl iodides and for pure hydrocarbons, was found to be applicable also to mixtures of these compounds. It is shown from a simple mechanism that total I_2 yields, total free-radical yields, and yields for HI produced and consumed can be calculated from a knowledge of the limiting rates of I_2 production (or consumption) at zero dose with added I_2, HI, and no additives. Differential rate expressions for HI and I_2 concentrations are readily obtained, but they cannot be integrated analytically. However, it was possible to integrate them numerically by the second-order Runge–Kutta method, using an IBM 709 computer. The computer program allows evaluation of the role of various parameters in determining the shape of experimental I_2 concentration vs dose graphs. Initial G values for production of I_2, HI, and free radicals are tabulated for various concentrations of the cyclohexane–methyl iodide mixtures, and trends are discussed in terms of mechanisms for energy localization in solution radiolysis. (auth)

42978 ELECTRON SPIN RESONANCE STUDIES ON THE PHOTOLYSIS OF RADICALS PRODUCED IN ETHYL MERCAPTAN AND ETHYL DISULFIDE BY X-IRRADIATION. Milliken, S. B.; Morgan, K.; Johnsen, R. H. (Florida State Univ., Tallahassee). Contract AT(40-1)-2001. J. Phys. Chem., 71: 3238-42(Sept. 1967). (ORO-2001-6).

The ESR and photochemical properties of radicals generated in ethyl mercaptan and ethyl disulfide by x irradiation at 77°K were studied. The initial products are postulated to be ion pairs with charges localized on the S atoms. Subsequent photolysis in the case of ethyl mercaptan results in formation of the RS radical whose presence was previously postulated in liquid ethyl mercaptan. (auth)

42979 RADIATION-INDUCED POLYMERIZATION OF ISOBUTENE IN THE GAS PHASE. Okamoto, Hidemasa; Fueki, Kenji; Kuri, Zen-ichiro (Nagoya Univ., Japan). J. Phys. Chem., 71: 3222-7(Sept. 1967).

The γ-induced polymerization of isobutene was investigated at 25°C in the gas phase to elucidate its reaction mechanism. The initial rate of polymerization was directly proportional to dose rate. The polymerization was markedly retarded by the presence of NH_3, indicating a cationic mechanism. Nitric oxide and nitrous oxide also showed considerable retarding effects on the polymerization. The rate of polymerization was enhanced by adding rare gases, Ar, Kr, and Xe. These results indicated that energy transfer from rare gases to isobutene occurs in mixtures of these gases. (auth)

42980 ELECTRON SPIN RESONANCE SPECTRA OF FREE RADICALS IN IRRADIATED CYCLOHEXANECARBOXYLIC ACID. Leung, Philip M. K.; Hunt, John W. (Univ. of Toronto, Ontario Cancer Inst., Toronto). J. Phys. Chem., 71: 3177-86(Sept. 1967).

The ESR spectra of irradiated cyclohexanecarboxylic acid (CCA) were observed following irradiation at 4 and 153°K. Following irradiation at 153°K, three free-radical species were detected, two being identified as $c\text{-}C_6H_{11}\cdot$ and $c\text{-}C_5\text{-}H_{10}\dot{C}\text{-}COOH$ (CCA radical). The CCA radicals were stable up to the melting point of the compound, with reversible changes in the spectra observed due to chair-chair interconversion. The cyclohexyl radicals decayed at about 188°K, some of them extracting hydrogen atoms from CCA molecules to give new CCA radicals. At least three transient species were detected in samples irradiated and observed at 4°K, one probably being the ion radical, $c\text{-}C_6H_{11}\text{-}\dot{C}\!<\!\begin{matrix}O^-\\OH\end{matrix}$. The ion radical and another species decayed when the temperature was increased to about 143°K, and the CCA radical grew in their place. (auth)

42981 RADIATION-INDUCED POLYMERIZATION BY FREE IONS. PART 3. RATE CONSTANTS FOR CATIONIC POLYMERIZATION. Williams, Ffrancon; Hayashi, Kanae; Ueno, Katsuji; Hayashi, Koichiro; Okamura, Seizo (Kyoto Univ.). Trans. Faraday Soc., 63: 1501-11(June 1967).

The general kinetics of radioinduced ionic polymerization are discussed and the effects resulting from impurity termination are analyzed quantitatively. A method is described for calculation of the propagation rate constants k_p by combining measurements of polymerization rates with conductivity determinations of the ionic lifetime in the stationary state. The rate constant for cationic propagation by free ions is ca 4×10^6 M^{-1} sec^{-1} for both styrene and α-methylstyrene in the bulk monomer. This large value suggests that the lower results obtained previously for styrene by the use of chemical cationic catalysts refer mainly to ion pairs of varying reactivity. (auth) (UK)

42982 PARAMAGNETIC RELAXATION OF TRAPPED ELECTRONS IN IRRADIATED ALKALINE ICES. Zimbrick, John; Kevan, Larry (Univ. of Kansas, Lawrence). J. Chem. Phys., 47: 2364-71(Oct. 1, 1967).

The paramagnetic relaxation characteristics of trapped electrons in γ-irradiated alkaline ices were studied by power saturation methods. The relaxation times were measured as a function of radiation dose, deuteration, phase, and temperature. Linewidths were measured under various conditions. The trapped electron EPR line was inhomogeneously broadened by nuclear hyperfine interactions; the spin-lattice relaxation mechanism was probably a cross relaxation process with O^-. The change in relaxation time with radiation dose indicated that the electrons were trapped with a nonuniform spatial distribution in hydroxyl anion vacancies in radiation-produced spurs of ~30 Å radius. (auth)

42983 THERMAL ELECTRON ESCAPE IN IRRADIATED DIPOLAR SYSTEMS. Schiller, Robert (Central Research Inst. for Physics, Budapest). J. Chem. Phys., 47: 2278-80(Oct. 1, 1967).

The possibility of thermal electron escape from the neighborhood of positive ions was studied from the point of view of the change of free energy. On the basis of a generalized spur (track) model a sufficient condition was formulated for the decrease of free energy in electron escape. This condition is fulfilled in every system if the electron–electron repulsion is high, or in polar systems if the diffusing electrons are not too fast. Short dielectric relaxation time and large difference between static and infrared dielectric constants increase the escape probability. (auth)

42984 RADIATION CHEMISTRY OF ICE. I. NATURE AND pH DEPENDENCE OF THE REDUCING SPECIES. Schiller, Robert (Central Research Inst. for Physics, Budapest). J. Chem. Phys., 47: 2281-3(Oct. 1, 1967).

The decisive role of dielectric relaxation time in the electron-escape process indicated by earlier theoretical studies was investigated by scavenger experiments in normal and supercooled water and crystalline ice. In these substances of similar dielectric constants but of different relaxation times, the importance of the latter is confirmed in that no free electrons could be detected in irradiated ice samples. A semiempirical law concerning the pH dependence of H-atom yield in irradiated ice is also inferred from the experimental results. (auth)

42985 UNSTABLE COMPLEXES OF IRON SEEN IN THE PULSE RADIOLYSIS OF AQUEOUS FERROUS PERCHLORATE. Jayson, G. G. (Liverpool Regional Coll. of Tech.); Stirling, D. A.; Swallow, A. J. Chem. Commun., No. 18, 931-2(1967).

A study is described of unstable products formed by reactions of OH and HO_2 radicals with ferrous ions, employing ferrous perchlorate in perchloric acid. The absorption spectrum of an air-saturated 10^{-3}M solution of the perchlorate in 1N perchloric acid at 20 μsec after a 600-R pulse of 4-MeV electrons is shown. Down to 260 nm the curve is in agreement with that expected for uncomplexed ferric ions formed from OH radicals, together with a small contribution from HO_2. When a higher concentration of ferrous ions was employed (10^{-2}M) the curve obtained at 2 μsec was similar to the foregoing above 280 nm, but dropped sharply below 280 nm, due to spectral impurity in the monochromator output. The absorption at 280 nm rose after a period of microseconds, and there was a higher proportionate rise in the range 350 to 600 nm, attributed to the action of HO_2 radicals. The spectrum obtained resembled that previously attributed to $Fe^{3+}HO_2^-$. Reduction of the acid concentration to 10^{-3}N ($Fe^{2+} = 10^{-2}$M) did not greatly affect absorption at 280 nm or above 400 nm, but resulted in greater absorption in the region 300 to 350 nm, resembling that seen when uncomplexed ferric is replaced by $Fe^{3+}OH^-$. For a 10^{-2}M ferrous perchlorate solution in 1N perchloric acid, pulsed in the absence of oxygen, a new band was observed in the region 300 to 350 nm, attributed to formation of a complex $Fe^{3+}H^-$. (UK)

42986 ELECTRON SPIN RESONANCE OF GAMMA-RAY IRRADIATED $Sr(NO_3)_2$, $Ba(NO_3)_2$, AND $Pb(NO_3)_2$. Kikuchi, Riichi; Nogaito, Takeshi (Osaka Univ.). Mem. Inst. Sci. Ind. Res., Osaka Univ., 24: 53-64(Feb. 1967).

In γ-irradiated single crystals of $Sr(NO_3)_2$, $Ba(NO_3)_2$, and $Pb(NO_3)_2$ four triplets and four singlets were observed in electron spin resonance at temperatures between 77°K and room temperature. Six of these paramagnetic species were assigned for NO_3, NO_3^{--}, NO_2, O_2^-, O_3^-, and O_4^-. Anisotropy of G values for NO_3^{--}, O_2^-, and O_3^- in $Pb(NO_3)_2$ were smaller than those in $Sr(NO_3)_2$ and $Ba(NO_3)_2$. (NSA of Japan)

42987 RADIATION-INDUCED TERPOLYMERIZATION OF SULFUR DIOXIDE, ACRYLONITRILES, AND OCTENE-1. Ito, Masayuki; Kuri; Zen-ichiro (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 70: 1011-12(June 1967). (In Japanese).

Terpolymerization of SO_2, acrylonitrile (AN) and octene (Oct) by ^{60}Co γ rays was investigated. The composition of polysulfones obtained was found to be of the form of $(AN)_x(SO_2-Oct)_y$, the ratio of Oct/SO_2 in the polysulfone was about 1/1, independent of monomer concentrations. Assuming the terpolymerization of this system to be the copolymerization of AN and SO_2-Oct complex C, the following result was obtained: $C/AN = (C=AN) \times [20(C) + AN]/[C + 0.2(AN)]$, where (C) is the concentration of the complex in starting materials and C is the mole fraction of SO_2–Oct in polysulfone. The polysulfones were soluble in DMF, and became soluble even in acetone or benzene, as the contents of AN in the copolymers decreased. (NSA of Japan)

42988 IONIZATION AND DISSOCIATION OF ALIPHATIC ETHERS UNDER ELECTRON IMPACT. Takezaki, Junichi; Hirota, Kozo (Japanese Association for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 183-91(Nov. 1966). (In Japanese).

Ionization potentials of ten aliphatic ethers and their positive charge distributions of each bond just after the moment of electron impact were calculated by the LCMO method. The calculated positive charge distributions showed a good correlation to the scission probabilities of the corresponding bond obtained from mass spectra, while the calculated ionization potentials did not change so much. (NSA of Japan)

42989 PHOTO-ANNEALING OF CHEMICAL RADIATION DAMAGE. Mohanty, S. R.; Nair, S. M. K. (Banaras Hindu Univ., India). Nature (London), 215: 1476-7(Sept. 30, 1967).

Evidence for radiation annealing, in the case of chemical radiation damage, is provided by the observation that the rate of damage generation decreases with increase in radiation dose. This effect is particularly pronounced in lead nitrate, for which the steady state nitrite yield under γ-irradiation is only about 2%. A study is described in which the recombination of damage fragments in lead nitrate was observed to occur under the action of visible light. Care was taken to ensure that the samples did not become heated during illumination. Plots of nitrite concentration versus time of illumination are illustrated. The plots lie on a straight line, which implies a monomolecular recombination process. It was found that annealing increased linearly with effective mean light frequency, and the threshold frequency for annealing was 42×10^{13} sec^{-1} (7140 Å), corresponding to an energy of 1.74 eV. The fact of recovery under the action of light indicates an electronic process. Lead nitrate was found not to be susceptible to photolysis by visible light. (UK)

42990 RADIOPHOTOLUMINESCENCE OF BIPHENYL IN METHYLCYCLOHEXANE GLASS. Deroulede, A.; Kieffer, F. (Faculte des Sciences, Orsay, France). Nature (London), 215: 1475-6(Sept. 30, 1967).

Studies are described in which a complete radiophotoluminescence (RPL) excitation spectrum of γ-irradiated glassy solutions of biphenyl in methylcyclohexane (between 360 mμ and 2.3μ) was obtained. The spectra are reproduced for 10^{-4}, 10^{-3}, and 10^{-2} molar biphenyl. The decay of the long-lived component of the luminescence is also illustrated. The observed effect of solute concentration indicated competition between traps and biphenyl molecules for electrons released during the irradiation. From the concentration dependence it was deduced that an electron can migrate up to 55 Å from the parent cation with little chance of being trapped in the matrix, but that within 250 Å, trapping in the matrix is nearly 100%, the average trapping distance being about 120 Å. This agrees with results obtained by other techniques. From the luminescence decay a lifetime of 4.05 ± 0.05 sec was determined for the long-lived excited state. Analogous studies with other aromatic hydrocarbons are in progress. (UK)

42991 STUDY ON ANTI-RADIATION FOR POLYMERS. Shibata, Takaharu; Hasebe, Morikuni (Furukawa Electric Co., Ltd., Japan). Furukawa Denko Jiho, No. 42, 70-7(Dec. 1966). (In Japanese).

The effectiveness of antioxidants as antiradiation materials for polymers was studied by adding equal moles of various antioxidants to low-density polyethylene, and then irradiating the mixture in air with elections from a linear accelerator. The changes induced in irradiated polyethylene, including swelling ratio, sol-gel ratio, tensile strength, and elongation were examined in order to find the protective effect of the antioxidants. Antioxidants of the phenol system have a highly protective effect. When action as an antioxidant is considered, 4, 4′-thiobis(6-tert-butyl-3-methylphenol) is the most effective. Certain of the antioxidants, called "peroxide decomposers," have superior protective effects, for example, dilduryl thiodipropionate. Sym-di-β-naphthyl-p-phenylenediamine, 2-mercaptobenzimidazole, and nordihydroqudidretic acid are promising antioxidants, which would not inhibit radiation bridge bonding. (NSA of Japan)

42992 IDENTIFICATION OF THE IONS PRODUCED FROM METHYL ETHYL ETHER-d_3 BY ELECTRON IMPACT. Takezaki, Junichi; Hirota, Kozo (Japanese Association for Radiation Research on Polymers, Osaka). Nippon Hoshasen Kobunshi Kenkyu Kyokai Nempo, 7: 193-7(Nov. 1966).

Mass spectra of several aliphatic ethers, measured by a double-focusing, high resolution mass spectrometer type was previously reported and an attempt made to determine the probability of their bond scissions. However, it was not obvious in methyl ethyl ether (MEE) whether CH_3^+ ion was produced from C–O bond scission or C–C bond scission. The ratio of CH_3^+ ion produced from C–O bond scission to that from the C–C bond scission could not be calculated for MEE, because it is difficult to distinguish both kinds of the CH_3^+ ion. To solve this problem, MEE-d_3 was synthesized, its mass spectrum was measured, and the ions produced were identified quantitatively. (NSA of Japan)

42993 PREPARATION OF CARRIER-FREE RADIOACTIVE TRACERS OF SELENIUM AND TELLURIUM. Hashimoto,

Yoshikazu; Winchester, John W. (Massachusetts Inst. of Tech., Cambridge). Radiochim. Acta, 7: 217(Aug. 1967).

The bombardment of an arsenic target with 15-MeV deuterons resulted in the production of 120-day ^{75}Se by the reaction ^{75}As (d,2n)^{75}Se. An antimony target was bombarded with 15-MeV deuterons, and 17-day ^{121m}Te, 150-day ^{121}Te, and 104-day ^{123}Te were produced by the nuclear reactions ^{121}Sb(d,2n)^{121}Te + ^{121m}Te and ^{123}Sb(d,2n)^{123}Te. Coprecipitation, distillation, ion exchange, and solvent extraction procedures are described for the preparation of high purity tracers. (P.C.H.)

42994 FATE OF TRAPPED RECOIL ATOMS IN HETEROGENEOUS REACTION SYSTEMS. MacKay, C.; Nicholas, J.; Wolfgang, R. (Yale Univ., New Haven. Haverford College, Pa.). Radiochim. Acta, 7: 219(Aug. 1967).

Studies on the reactions of thermalized recoil ^{11}C with ethylene and 2-butene are discussed. In some experiments the ^{11}C was allowed to recoil into pure solid xenon matrices. Reagent was then added and the matrix allowed to gasify and mix with the alkene. Invariably, the only reaction products of the ^{11}C observed were ^{11}CO and $^{11}CO_2$. Reasons for this are discussed. (P.C.H.)

42995 A STUDY OF THE RECOIL BEHAVIOR OF ^{56}Mn ATOMS IN DILUTE SOLUTIONS OF MANGANESE CARBONYL COMPOUNDS. Zahn, U. (Technische Hochschule, Munich). Radiochim. Acta, 7: 170-5(Aug. 1967).

The concentration and temperature dependence of ^{56}Mn retention after the neutron bombardment of dilute solutions of cyclopentadienyl manganese tricarbonyl, $C_5H_5Mn(CO)_3$, and dimanganese decacarbonyl, $Mn_2(CO)_{10}$, in various organic solvents were studied. The concentration and temperature independent part of the parent compound retention is very low and primary in its nature, due to failure of bond rupture after the (n,γ) reaction. Secondary, thermal diffusive reactions start to contribute to the retention in solutions of higher concentrations of $C_5H_5Mn(CO)_3$, and can be further enhanced by increasing the applied γ dose. A contribution of hot exchange reactions could be excluded by a scavenger technique. (auth)

42996 NUCLEAR REACTIONS OF BROMINE IN THE CBr_4–C_2H_5OH SYSTEM: A RE-EVALUATION. Iyer, R. M.; Willard, J. E. (Univ. of Wisconsin, Madison). Radiochim. Acta, 7: 175-7(Aug. 1967).

The organic yields of ^{82}Br and ^{80m}Br following neutron irradiation of 6.5×10^{-4} mf CBr_4 in C_2H_5OH are ca 20 and 13%, respectively, in contrast to the yield of 0% inferred from earlier work. Approximately 60% of the yield in each case was divided between CH_3Br, C_2H_5Br and C_2H_4BrOH. Special techniques were designed for the analysis of this system. (auth)

42997 CHEMICAL EFFECTS OF BROMINE ACTIVATED BY THE ISOMERIC TRANSITION ^{82m}Br → ^{82}Br IN BINARY ORGANIC MIXTURES. II. REACTIONS IN MIXTURES OF METHANOL AND BENZENE: METHANOL AND IODOBENZENE, BENZENE AND IODOBENZENE. Stamouli, Maria I.; Katsanos, Nicholas A. (Democritus Nuclear Research Center, Athens). Radiochim. Acta, 7: 177-81(Aug. 1967).

The chemical effects of ^{82}Br, activated by the isomeric transition of ^{82m}Br(Br_2) in various binary mixtures of methanol, benzene, and iodobenzene, were studied in order to decide between the equilibrium hypothesis among various intermediate complexes developed earlier and a simple collision model. The results are discussed on the basis of both interpretations. Experimental findings fully confirm the predictions of the first hypothesis and are inconsistent with the second. (auth)

42998 NEUTRON ACTIVATION OF COBALTOCENE AND NICKELOCENE. Wheeler, Owen H.; McClin, Maria Luisa (Puerto Rico Nuclear Center, Mayaguez). Radiochim. Acta, 7: 181-5(Aug. 1967).

The radioactive products formed in the neutron activation of cobaltocene and nickelocene were separated by solvent extraction. Nickelocene gave 65% retention of activity, and 35% as nickelous ion. Cobaltocene afforded 25% retention, 15% as cobalticinium ion, and 5% as cobaltous ion. For ^{60m}Co the activity of the cobalticinium fraction was greater. Annealing increased the retention in all cases. (auth)

42999 A RADIOCHEMICAL PREPARATION OF TRICYCLOPENTADIENYL-PROMETHIUM. Baumgaertner, F. (Univ., Heidelberg); Fischer, E. O.; Laubereau, P. Radiochim. Acta, 7: 188-92(Aug. 1967).

It was found that in the β^--decay of ^{151}Nd in $(C_5H_5)_3$Nd the daughter product is $(C_5H_5)_3$Pm. This new compound of promethium is closely similar to $(C_5H_5)_3$Nd in its sublimation behavior, its solubility in ether, and its sensitivity to hydrolysis. (auth)

43000 THE p_H DEPENDENCE OF THE OXIDATION STATES OF RECOIL ^{54}Mn IN CRYSTALLINE POTASSIUM PERMANGANATE. Lecington, W. C.; Owens, C. W. (Univ. of New Hampshire, Durham). Radiochim. Acta, 7: 212-14(Aug. 1967).

The effects of solvent p_H on the relative yields of cationic ^{54}Mn, $^{54}MnO_2$, and $^{54}MnO_4^-$ produced in $KMnO_4$ by the ^{55}Mn(n,2n) ^{54}Mn reaction have been investigated. The yields of $^{54}MnO_4^-$ and $^{54}MnO_2$ increase at both low and high p_H. The results are compared to results obtained by others with ^{56}Mn. (auth)

43001 ON THE RADIATION-CHEMICAL INTERPRETATION OF THE SPECIFIC ACTIVITY VALUES OBTAINED BY THE SZILARD–CHALMERS REACTION OF SOME COBALT COMPLEX IONS. Matsuura, T. (Rikkyo Univ., Yokosuka, Japan). Int. J. Appl. Radiat. Isotop., 18: 697-708(Oct. 1967).

Since the specific activity of the enriched fraction from the Szilard–Chalmers reaction of $Co(NH_3)_6^{3+}$ and $Coen_3^{3+}$ ions adsorbed on an ion-exchange resin was found to depend greatly on irradiation conditions in the reactor used, a theoretical analysis was attempted by calculating the dose adsorbed by the sample in the various types of radiation and by estimating the appropriate G values. The major part of the adsorbed dose was calculated to be due to the reactor gamma rays, and the residual part to fast-neutron collisions and recoil rays from the $^{14}N(n,p)^{14}C$ reaction. By using the G values experimentally determined for gamma rays (2.8 and 1.0 for $Co(NH_3)_6^{3+}$ and $Coen_3^{3+}$ ions respectively), and by assuming the G values for the corpuscular radiations to be 5, it was found that the magnitude of the calculated specific activity agreed well with the observed data. (auth) (UK)

43002 MEASUREMENT OF LOCAL CONCENTRATIONS OF FREE RADICALS IN AMORPHOUS MATRICES. Bullock, A. T.; Griffiths, W. E.; Sutcliffe, L. H. (Univ. of Liverpool). Trans. Faraday Soc., 63: 1846-9(Aug. 1967).

Further data supporting a previous assertion that free radicals formed in the gamma radiolysis of poly(methyl methacrylate) are trapped in spurs were obtained. The technique used was to determine the local radical concentrations by measuring the width of the Lorentzian spin packets of the inhomogeneously broadened ESR lines. The values obtained are compared with the average concentrations over the sample found by a standard comparison method. (auth) (UK)

43003 HYDROGEN YIELDS IN THE γ-RADIOLYSIS OF 1,4-DIOXAN AND DIOXAN + WATER MIXTURES. Baxendale, J. H.; Rodgers, M. A. J. (Univ. of Manchester, Eng.). Trans. Faraday Soc., 63: 2004-11(Aug. 1967).

Yields of hydrogen from γ-irradiated pure dioxan were found to be lower than previously reported (1.26 compared with 2.1). Addition of water increased this yield to 2.45, and if D_2O was used the extra hydrogen appeared as HD. Hydrogen atom, but not electron scavengers, reduced $G(H_2)$ from pure dioxan, whereas the extra yield of hydrogen from aqueous dioxan can be inhibited by electron scavengers. Reaction mechanisms involving cations are suggested. It is concluded that the yield of electrons $G(e^-) = 2.2$. (auth) (UK)

43004 ELECTRON SPIN RESONANCE STUDIES OF γ-IRRADIATED SINGLE CRYSTALS OF AROMATIC COMPOUNDS. PART II. RESULTS FOR DIPHENYLACETIC ACID AND GENERAL PROBLEMS OF INTERPRETATION. Atherton, N. M.; Harding, R. S. F. (Univ. of Sheffield, Eng.). J. Chem. Soc. A, No. 9, 1490-1(1967).

The radical trapped in diphenylacetic acid was identified as diphenylmethyl, and the spectral data were compared with those previously obtained for this radical in diphenylmethane. Some of the problems encountered in attempts to interpret the spectra of irradiated crystals of aromatic compounds are discussed, and possible ways of circumventing them are suggested. (auth) (UK)

43005 RADIATION-INDUCED POSTPOLYMERIZATION OF TRIOXANE IN SOLID STATE. Sakamoto, M.; Ishigaki, I.; Kumakura, M.; Yamashina, H.; Iwai, T.; Ito, A.; Hayashi, K. (Japan Atomic Energy Research Inst., Takasaki). J. Macromol. Chem., 1: 639-55(Oct. 1966).

A kinetic study of the radioinduced postpolymerization of trioxane in the solid state was made. The yield and the degree of polymerization of the polymer were estimated as a function of the preirradiation dosage and postpolymerization temperature. The yield–polymerization-time curves can be represented by an exponential equation. The degree of polymerization increases with the conversion. This means that the rate constant of the formation of active species is much larger than that of the termination reaction (k_t); $\tau = 1/k_t$ represents the average lifetime of the active species; the lifetime of the active species in the postpolymerization was calculated to be 10^4 to 10^5 sec. This value was found to be much larger than for the in-source polymerization. (auth)

43006 EFFECT OF PRESSURE ON SOLID-STATE POLYMERIZATIONS OF DIKETENE AND TRIOXANE. Tabata, Y.; Suzuki, T.; Oshima, K. (Tokyo Univ.). J. Macromol. Chem., 1: 817-20(Oct. 1966).

The pressure effect on solid-state in-source polymerization of the cyclic monomers diketene and trioxane was investigated by irradiating the diketene monomers with ^{60}Co γ rays under atmospheric pressure and at 5000 kg/cm² in a steel reaction vessel and by irradiating the trioxane under atmospheric pressure and at 4000 kg/cm² at 55°C. A pretreatment pressure effect was investigated for the diketene monomers at temperatures of –13, –78, and –196°C. The rate of polymerization of diketene in the solid phase was found to decrease rapidly near the melting point with increasing temperature, and the accelerating effect of pressure was remarkable near the melting point. In sharp contrast is the suppression of polymerization of trioxane by increasing pressure. (B.L.M.)

43007 MASS SPECTROMETRY INVESTIGATION OF THE RADIOLYSIS MECHANISM OF PETROLEUM PRODUCTS USING THE EXAMPLE OF TETRAHYDRONAPHTHALENE. Wincel, Henryk. Warsaw, Inst. of Nuclear Research, 1965. (In Polish). Thesis.

The radiolysis mechanism of petroleum products was investigated by mass spectrometry using tetrahydronaphthalene (THN) as an example. A theoretical part, which discusses the basic investigation methods most frequently used in radiation chemistry, and an experimental part where a discussion of the experimental methods is followed by an analysis of the fundamental radiochemical processes forming the individual links in the radiolysis mechanism model of THN in the liquid phase are presented. (JPRS)

43008 THE EFFECT OF OPTICAL AND HIGH-ENERGY RADIATION ON THE REDUCTION AND OXIDATION REACTIONS OF THE U(VI) AND U(IV) IONS IN AQUEOUS SOLUTIONS. Sobkowski, Jerzy. Warsaw, Warsaw Univ., 1964. (In Polish). Thesis.

The effect of optical (405 mμ) and gamma ^{60}Co radiation on reduction and oxidation processes occurring in solutions of U(VI) and U(IV) ions was examined. Optical radiation caused the reduction of U(VI) ions to U(V), which subsequently underwent disproportionation to U(IV) and U(VI). The kinetics of these processes were followed by measuring the redox potential of a platinum electrode. Measurements were done in a perchlorate solution in the presence of compounds capable of complexing U ions. Investigation of the effect of ^{60}Co gamma radiation on the process of U(IV)-ion oxidation to U (VI) is described. The radiative-oxidation efficiency of U(IV) as a function of U(IV), H, and perchlorate ion concentrations in solution was determined. Formation of an intermediate-oxidation product was observed using polarography. A radiative U(IV)-oxidation-reaction mechanism is proposed. (JPRS)

43009 RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS. Czerwik, Wladyslaw. Lodz, Poland, Lodz Polytechnic Inst., 1965. (In Polish). Thesis.

Processes occurring during irradiation of ice and frozen aqueous solutions were studied. Frozen samples were subjected to the action of ^{60}Co, ^{90}Sr, ^{3}T, and 40 kV radiation. The effects of radiolysis were determined by the radical-scavenger method after melting. This technique was used to determine the dependence of the yield of G (Fe^{3+}) on temperature in the range –196 to –13°C for the types of radiation listed above. EPR spectra of the irradiated systems at 77°C were used to determine the stabilization conditions of frozen free radicals. These investigations were supplemented by Frick's thermal analysis of frozen solutions and determination of the effect of pH on the formation of hydrogen peroxide in frozen aqueous solutions. (JPRS)

Radiochemistry

Refer also to abstract 43059.

43010 (INR-811/XIII/C) METODY RUTYNOWEJ KONTROLI CZYSTOSCI CHEMICZNEJ I RADIOCHEMICZNEJ PREPARATOW RADIOIZOTOPOWYCH. I. PREPARATY ^{51}Cr. (Routine Chemical and Radiochemical Purity Control of Radioisotopic Preparations. I. ^{51}Cr Preparations). Nowak, Kazimierz; Pasternak, Antoni (Institute of Nuclear Research, Krakow (Poland)). 1967. 14p. (In Polish). Dep.

Methods for routine chemical and radiochemical control of ^{51}Cr preparations, $CrCl_3$ and Na_2CrO_4, are given. For total Cr determination a colorimetric method is used. The sample is oxidized with few drops of 1% $KMnO_4$ solution and heated on the water bath for 40 min. $KMnO_4$ oxidizes Cr(III) to Cr(VI) and destroys H_2O_2, which is used for stabilizing Cr(VI) form in Na_2CrO_4 preparations. The excess $KMnO_4$ is destroyed by a 0.5% sodium azide solution. After adding 1 ml 0.25% solution of diphenylcarbazide in 95% ethyl alcohol the optical density of Cr(VI) diphenylcarbazide complex was measured at a wavelength of 540 nm. The Cr content was calculated by use of a calibration curve. Standard error for a single determination was about 6%. For radiochemical purity control ascending paper chromatography was used. Each section of paper was rolled up and the activity of twists subsequently measured using a well-counting NaI crystal. The quantity of impurities was calculated as percent of activity in proportion to the total activity of the strip. One standard error of determination was not higher than 5%. The accuracy of measurements was about 4.5%. (auth)

43011 (IS-T-191) RECOIL REACTIONS OF ^{11}C IN BINARY MIXTURES OF LIQUID HYDROCARBONS. Matkovich, Charles Edward (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 53p. Dep. CFSTI. Thesis.

Radioactive products due to reactions of recoil ^{11}C in binary mixtures of liquid hydrocarbons were studied. Unsaturated parent compounds were postulated to act as scavengers that can remove radical intermediates and thereby reduce the yields of products having radical precursors. The amount of unsaturation of the parent may determine its ability to act as a scavenger. Several products were found to be dependent only on the composition of the mixture and these products were postulated to arise from hot reactions and to have no radical precursors. Certain products with the same number of carbon atoms as the scavenger parent plus one showed yield increases in the mixture and are thought to be the product of scavenger and radical reactions. A few products exhibited very complicated behavior and are not the result of simple reactions. Most products can be explained by using the reaction mechanisms of ^{11}C, ^{11}CH, $^{11}CH_2$ insertion into a CH or C = C bond, fragmentation or stabilization, and H abstraction. (auth)

43012 REPORT OF THE GOVERNMENT CHEMIST, 1966. London, Her Majesty Stationary Office, 1967. 182p. 15s.

The report contains a section on radiochemistry, covering the following topics: fallout in drinking water; fallout in London rainwater; tritium determination in natural waters; neutron activation analysis; liquid scintillation counting; calibrated radium standards; and alpha spectrometry. (UK)

43013 STABILITY OF LABELLED ORGANIC COMPOUNDS. R.C.C. Review 3. Revised Edition. Catch, John R. Amersham, Bucks, Eng., The Radiochemical Centre, 1967. 15p. UK.

The decomposition of labeled compounds is discussed, including primary and secondary effects. Special cases, precautions, and decomposition during experiments are also discussed. (P.C.H.)

Separation Processes

Refer also to abstracts 42962, 43088, 43290, and 43565.

43014 (AERE-M-1236) EFFLUENT PROCESSING: THE PRINCIPLES OF THE FOAM SEPARATION PROCESS AND SOME PRELIMINARY EXPERIMENTAL RESULTS. Banfield, D. L.; Newson, I. H. (Atomic Energy Research Establishment, Harwell (England)). Aug. 1963. 24p. Dep. CFSTI. UK.

Foam separation as a means of removing radioactive ions from dilute effluent streams is described. The properties of surface active agents in solution are first discussed and the equations governing the transfer process within a foam column are derived. Using these equations calculations of the performance of foam columns with respect to removal of surfactant have been made. These show firstly that the decontamination factor, with respect to surfactant, increases as its concentration in the feed liquor to the column decreases. This property of the process is confirmed by experimental results. By inference there is an upper limit of surfactant concentration in the feed liquor beyond which the foam separation process would not be used; this is about 10^{-2} molar. The likely flow scheme of the foam separation process has been considered. This is envisaged as a number of columns (4) through which the feed solution flows in series. With surfactant make-up between columns to maintain the foaming power of the solutions the overall decontamination of the ionic species will be the product of the decontaminations achieved over each column; it is believed that the overall decontamination factor could be of the order 10^8. The other characteristics of foam column operation in series are also discussed. Preliminary experiments were conducted in a 1½ in. bore column using the surfactants potassium laurate and potassium palmitate in water buffered with potassium carbonate to prevent hydrolysis. The results obtained followed qualitatively the predictions made from the derived theoretical equations. Thus with the more concentrated potassium laurate feed solutions (laurate ion concentration 3×10^{-3} molar) decontamination factors between 1 and 2 were obtained; with the comparatively dilute feed solution of potassium palmitate (palmitate ion concentration 2×10^{-4} molar) decontamination factors up to 1300 were obtained.

Using 3 in. bore diameter foam drainage sections volume reductions of 300–400 were easily obtained. (auth)

43015 (EURAEC–1909) REPROCESSING OF IRRADIATED FUELS. Special Report No. 8. Annual Report, July 1965–June 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7RCIB(RD); 016-65-1RAP-B. 40p. (EUR-3394). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The basic research concerned the different stages of the reprocessing cycles envisaged. The effect on the output and sintering of the reprocessed powders of the PuO_2 content in fission products and in alumina (used in the fluid-bed technique) was examined. Various cycles were compared. The preferential sublimation of uranium and plutonium was investigated. Tests were effected relative to the chemical decanning of nuclear fuels. Tests were made of the fluorination of nuclear fuels by different fluorinating agents used alone or mixed together. The relative reactivities of the different mixtures were determined. Research was conducted on the absorption of fluorinating agents by solid substances (more compact and easier to handle and store than alkaline solutions) with a view to removing surplus reagents. Fission products capable of being volatilized during the fluorination stage were determined and their absorption by various solid compounds with a view to separating them from uranium and plutonium was investigated. The construction and the equipment of the various laboratories were continued. (auth)

43016 (GAMD–6360) FEASIBILITY STUDY FOR REPROCESSING HTGR FUELS BASED ON USING THE NUCLEAR FUEL SERVICES, INC., REPROCESSING PLANT. Reese, S. L.; Burn, P. (Nuclear Fuel Services, Inc., West Valley, N. Y.); Donelson, S. E.; Steyer, K. G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 15, 1964. Contract AT(04-3)-167; Subcontract 1143. 67p. Dep. CFSTI.

Technology regarding recovery and storage of fuel elements is reviewed. Processes amenable to the recovery of U and Th values from HTGR fuel are discussed. The alternatives considered for receiving and storing the fuel were to unload and store under water as presently practiced with metal-clad fuels, or to unload in a concrete shielded cubicle and store dry. Dry storage was chosen for the following reasons: (1) Under dry storage conditions, the elements may be stored uncanned or in simple protective containers, thereby eliminating water-tight containers. (2) The currently proposed rail cask can be easily unloaded if the cask is not removed from the car and transferred to an unloading pool. In addition, a 125-ton crane would be required to lift the proposed rail shipping cask. (3) A new storage area would be required at the NFS plant since the length of the elements exceeds the present storage-pool design maximum by four feet. (4) The decay heat can be removed from the element in dry storage with a reasonable amount of circulating air. To process this fuel chemically, the graphite and carbon must be broken down or separated from the fuel to permit further dissolution reactions. The basic processes reviewed were burn–leach, grind–leach, burn–fluoride volatility, and wet burning. The burn–leach process was the most desirable for processing HTGR fuels. The grind–leach process was rejected principally because operation, maintenance, and dust problems associated with fine-grinding equipment appear formidable in hot operations. In addition, no satisfactory method of separating the fine graphite powder from the leach solution has been devised. The burn–fluoride volatility process was not considered suitable for HTGR oxide fuels since the thorium associated with the uranium forms a nonvolatile fluoride resulting in poor uranium separation. In addition, thorium recovery is not practical using the fluoride volatility process. The wet burning process at the present stage of development, is not suitable for recovery of HTGR fuels since complete dissolution of the oxides of uranium and thorium has not been achieved in the reagents tried. Future developments may make this process attractive. The feasibility of recovering the thorium for reuse after ten to fifteen years of cooling was examined. Three process schemes were found technically feasible. These are (a) extraction from the waste in a separate two-column system; (b) separation from the U by stripping the Th into an aqueous scrub stream in the present plutonium partition column; and (c) extraction of both U and Th in the partition-extraction cycle followed by separation of the two in the first uranium-cycle extraction column. The Th would be discharged as a product in the aqueous waste stream from this column. Process (a) requires considerable capital expenditure in the form of a separate extraction system. Process (b) results in uranium refluxing and critically unsafe concentrations could be reached near the top of the partition column. Process (c) is unique in that it combines features of two processes that have been demonstrated to give satisfactory results. It appears that safe uranium concentration can be maintained in the purification columns without loss of throughput using process (c). In addition, modifications to processes currently used would be much less extensive than those required for installation of a single cycle extraction facility. A preliminary study of a reprocessing facility for HTGR fuels was generated based on developing facilities for preparing the fuels for introduction into a solvent extraction process. It provides for fuel receiving, dry unloading, dry storage, semi-continuous crushing, continuous burning, batch leaching, and storage for column feed. Connections to the solvent-extraction system are also included as is the necessary waste storage. Except for the thorium-recovery processes, all operations could be performed in a conventional solvent extraction plant using service facilities without major changes. (P.C.S.)

43017 (GAT–216(Pt.3)) GAT TECHNICAL SEMINARS, FEED PLANT TECHNOLOGY. Penland, B. W. (Goodyear Atomic Corp., Portsmouth, Ohio). Dec. 6, 1955. Contract AT(33-2)-1. 17p. Dep. CFSTI.

The feed plant at Portsmouth, being designed to convert UF_4 to UF_6, is described. The chemical reactions involved in making UF_4 and converting it to UF_6 are discussed. The general layout of the plant is shown. The process and equipment are described. (M.C.G.)

43018 (IS-T-174) ANALYTICAL SEPARATIONS USING CHELATING ION EXCHANGE AND PARTITION CHROMATOGRAPHY. Schmitt, Donald Henry (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 77p. Dep. CFSTI.

Thesis.

Uranium(VI) was separated quantitatively from most other metal ions by partition chromatography on a silica gel column. The column was treated with aqueous 6 M nitric acid; after sorption of the sample, uranium(VI) was selectively and rapidly eluted by methyl isobutyl ketone. In addition to the separation of macro quantities of metal ions, the method has been used successfully for the isolation of trace amounts of metal ions from uranium(VI). A study was made of cellulose phosphate as a chelating ion exchanger in an aqueous hydrochloric acid system. Weight distribution coefficients for the rare earths, alkaline earths, alkali metals, and a few other metals were determined. Successful separations of rare earths and alkaline earths, alkaline earths and alkali metals, and aluminum and alkaline earths were achieved on cellulose phosphate columns. The components of complex samples, one containing uranium, erbium, and magnesium and the other uranium, aluminum and nickel, were quantitatively separated by combining the two methods. (100 references). (auth)

43019 (KFK–565) DER GESCHLOSSENE BRENNSTOFFZYKLUS, EINE EINFUEHRUNG. (The Closed Fuel Cycle, An Introduction). Haefele, W. BRENNSTOFFZYKLUSINDUSTRIE IN EINER EXPANDIERENDEN KERNWIRTSCHAFT. (Fuel Cycle Industries in an Expanding Nuclear Economy). Gupta, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Feb. 1967. 21p. (In German). Dep.

The central hypotheses in a discussion of the closed fuel cycle are tabulated. On the basis of a plausible nuclear energy growth rate in Germany, the annual output fabrication and processing installations for various reactors and the amounts of fission products resulting are estimated and the results are discussed. The production of enriched U from a U separation plant in Europe is considered. The numbers discussed for the fuel cycle industries are dependent on introduction data as well as nuclear energy growth rate, reactor type, and reactor properties, but some general tendencies can be determined. (J.S.R.)

43020 (ORNL-TM–1206) FLUIDIZED BED VOLATILITY: PROCESS DESIGN FOR BrF_5 FLUORINATION AND UF_6 RECOVERY. Guthrie, C. E. (Oak Ridge National Lab., Tenn.). July 28, 1965. Contract W-7405-eng-26. 7p. Dep. CFSTI.

A process design is presented in which a single piece of equipment is used for UF_6, BrF_3, and BrF_5 recovery; UF_6 purification; and conversion of BrF_3 to BrF_5. (auth)

43021 (ORNL-TM–1885) SOME PROSPECTS FOR CHEMICALS RECOVERY FROM LARGE DESALINATION PLANT BRINE EFFLUENT. Neumann, P. D. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

A study was made of the potential savings in by-product recovery costs, which would result from the changes in chemical and physical properties of the brine effluent from a large-scale desalination plant when compared to raw seawater. These differences include concentrations, temperature, pH, and alkalinity.

The only recovery processes considered are those that are currently used for large-scale recovery of primary chemicals from seawater or natural brines. After a review of related recent literature, the three products judged most likely to be profitable were bromine, magnesium metal, and refined sodium chloride. Capital cost estimates and manufacturing costs estimates were assembled for plants operating on both seawater and the 2:1 concentrated seawater expected as effluent from the water plant. The savings in production costs are tabulated for each product. An analysis of the effect of land cost on plant economics is given because of the high cost of real estate in the vicinity of the proposed MWD plant. Within the limits set for this study, only the bromine plant appeared to be economically attractive. (auth)

43022 (RFP-999) HYDROGEN ISOTOPIC ANALYZER. Johnson, Charles M.; Connell, John M. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 11, 1967. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

A simple cryogenic gas chromatograph for the separation and analysis of the isotopes of hydrogen was designed and built. Its unique feature is the immersion of the thermal conductivity detector in liquid nitrogen to increase sensitivity. (auth)

43023 (RL-SEP-147) GEOMETRICALLY FAVORABLE PLUTONIUM SCRAP RECOVERY PLANT. Bruns, L. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Jan. 25, 1965. Contract AT(45-1)-1350. 24p. (CONF-650559-10). Dep. CFSTI.

From American Institute of Chemical Engineers, 56th National Meeting, San Francisco.

Types of plutonium scrap and the basic flowsheet for processing the scrap are discussed. Unique factors that affected design of the Plutonium Reclamation Facility at Hanford are reviewed. The facility itself is discussed with examples of unique factor application. The first 8 months' performance is summarized. (auth)

43024 (UJV-1665) HYDRODYNAMIC EXPERIMENTS WITH WATER–NITRIC ACID–URANYL NITRATE–30 PERCENT TRIBUTYL PHOSPHATE SYSTEM IN HORIZONTAL PULSED EXTRACTOR. Sraier, V.; Michalek, S. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 16p. Dep.

The working regions of a horizontal pulsed extractor were determined with the water–nitric acid–uranyl nitrate–30% tributyl phosphate system for conditions of the Purex process for regeneration of irradiated nuclear fuel. (auth)

43025 (UJV-1763) SOOSAZHDENIE STRONTSIYA S SERNOKISLYM SVINTSOM IZ RADIOAKTIVNYKH SBROSNYKH RASTVOROV. Laboratornoe Issledovanie. (The Coprecipitation of Strontium with Pb(II) Sulphate from the Radioactive Wastes. Laboratory Studies). Shistkova, N.; Kolarzhik, Z. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 27p. (In Russian). Dep.

The coprecipitation of Sr with Pb(II) sulfate from simulated Purex wastes (SPW) was studied. The influence of the following factors was examined: rate of lead ion addition; duration of stirring after precipitation; order of addition of precipitating agents; temperature of the mixture at the respective stages; and total concentration of the precipitating agents and of some components of SPW. The coprecipitation of the other fission products was also investigated. Conditions of the precipitation operation were proposed under which it is possible to recover more than 95% of the strontium by threefold coprecipitation. The possibliity of repeated use of lead from the second and the third coprecipitations was shown. The sorption of strontium on a previously prepared precipitate of Pb(II) sulfate was elucidated. (auth)

43026 CATION-EXCHANGE BEHAVIOUR OF SEVERAL ELEMENTS IN NITRIC ACID–ORGANIC SOLVENT MEDIA. Korkisch, J.; Feik, F.; Ahluwalia, S. S. (Univ., Vienna). Talanta, 14: 1069-81(Sept. 1967).

The cation-exchange behavior of 19 elements (including U, Th, Sr) towards the strongly acidic cation-exchange resin Dowex 50-X8 in media containing varying concentrations of organic solvents and aqueous nitric acid is reported. Based on the determination of the distribution coefficients of these elements in the organic solvents methanol, ethanol, n-propanol, isopropanol, methyl glycol, acetone, tetrahydrofuran, and acetic acid, the conditions most suitable for their quantitative separation are indicated and discussed. (auth) (UK)

43027 SOME ASPECTS OF RADIOCHEMICAL SEPARATION METHODS. Betteridge, D. (University Coll. of Swansea, Eng.). Chem. Zvesti, 21: 629-37(1967).

Ion-exchange and solvent-extraction radiochemical separation methods are discussed. Zirconium phosphate, ferrocyanide, and chromium polyphosphate glass inorganic ion exchangers are considered. Reverse-phase partition chromatography, countercurrent distribution, and solvent effects in solvent-extraction processes are discussed. (M.C.G.)

43028 SEPARATION OF RARE EARTHS ORIGINATING FROM URANIUM FISSION BY ELECTROPHORETIC ION FOCUSING. Guenther, E. W.; Starke, K. (Univ., Marburg, Ger.). Chem. Zvesti, 21: 561-70(1967). (In German).

Electrophoretic ion focusing was investigated for its suitability in separation of short-lived rare earths. A rare earth mixture was fractionated from fission products in 5 min by solvent extraction, precipitation, ruthenium distillation, and anion exchange. The La, Ce, Pr, and Y fractions were identified by γ spectra and half-life and found to be radiochemically pure. (tr-auth)

43029 SEPARATION OF ^{106}Ru FROM FISSION PRODUCTS ON INORGANIC REDOX ION EXCHANGERS. Winkler, R.; Sansoni, B.; Starke, K. (Univ., Marburg, Ger.). Chem. Zvesti, 21: 571-8(1967). (In German).

^{106}Ru was separated from a two-year-old fission-product mixture on an inorganic redox ion exchanger. The ^{137}Cs, ^{90}Sr, and rare earth (^{90}Y, ^{144}Ce, ^{144}Pr, and ^{147}Pm) nuclides bound at the same time on the ion exchanger could be selectively eluted. The ruthenium was separated by oxidative elution in about a 70% yield. The rest of the ruthenium and cerium, ^{95}Zr, and ^{95}Nb remained on the column under the conditions considered. (tr-auth)

43030 PAPER CHROMATOGRAPHIC STUDIES OF THE ALKALINE EARTH METALS WITH SOLVENTS CONTAINING CHLOROFORM. Poonia, N. S.; Sahni, N. S. (Vikram Univ., Ujjain, India). Indian J. Chem., 5: 203-6(May 1967).

A number of solvent mixtures of chloroform with different organic solvents and organic and mineral acids were tried in the paper chromatographic separation of alkaline earth metals, viz., Be, Mg, Ca, Ba and Sr, and a comparison made with those solvent systems without chloroform. The solvent systems chloroform–methanol–HCl (6:6:0.8) and chloroform–methanol–acetone–HCl (2:2:2:1) are quite suitable for the separation of metals of the alkaline earth group. (auth)

43031 FRACTIONATION OF SULFUR ISOTOPES IN HIGH-TEMPERATURE DECOMPOSITION OF SULFIDES BY WATER VAPORS. Grinenko, V. A.; Grinenko, L. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow. Central Scientific Research Mining and Prospecting Inst. of Rare, Disseminated, and Precious Metals, Moscow). Geokhimiya, No. 9, 1049-55 (Sept. 1967). (In Russian).

The separation of sulfur isotopes by the decomposition of sulfides by water vapor in the hydrogen and nitrogen atmosphere in the range of 300 to 600°C has been studied. It was found that the emanating hydrogen sulfide is enriched in the ^{34}S isotope in comparison with the initial sulfide, the enrichment depending on the mineral species of sulfide and amounting to 0.09 to 0.46%. In a joint emission of H_2S and SO_2 a redistribution of isotopes between these sulfur forms occurs and SO_2 is enriched in the ^{34}S isotope in comparison with H_2S. This indicates that an isotope exchange reaction proceeds between H_2S and SO_2, the experimentally found separation factor of which approaches the theoretical one and is 1.006. The data obtained are discussed in connection with the interpretation of isotope ratio variations in natural processes. (auth)

43032 GAS CHROMATOGRAPHY OF ISOTOPIC MOLECULES: ANALYTICAL AND PREPARATIVE SCALE SEPARATIONS OF C_2H_2, C_2HD, AND C_2D_2. Van Hook, W. Alexander; Phillips, James T. (Univ. of Tennessee, Knoxville). J. Chromatogr., 30: 211-14(Sept. 1967).

Preparative gas chromatography was used to purify C_2HD. Macroscopic amounts of C_2HD were separated from equilibration mixtures using multiple chromatography since the efficiency of preparation separation was low. The product after 3 runs showed ~98% C_2HD (~1.3% CH, <1% C_2D_2). The chromatographic analysis was consistent with infrared results. (D.H.M.)

43033 CONTINUOUS DISSOLUTION IN A PACKED BED. Carley-Macauly, K. W.; Moulton, R. J. (Atomic Energy Research Establishment, Harwell, Eng.). Chem. Process Eng., 48: 83-90(Sept. 1967).

Continuous dissolution of solid particles may possess advantages over batch processing, if only because of the smaller volume required. The use of a simple tubular dissolver was examined for dissolving sintered UO_2 in nitric acid, potentially applicable to the first stages in the processing of irradiated fuels, and compared with theoretical behavior. The aspects of dissolution as a unit operation are of much wider scope in the chemical industry. (auth) (UK)

43034 THE AMALGAMATION BEHAVIOUR OF HEAVY ELEMENTS. I. OBSERVATION OF ANOMALOUS PREFERENCE IN FORMATION OF AMALGAMS OF CALIFORNIUM, EINSTEINIUM, AND FERMIUM. Maly, J. (Univ. of California, Berkeley). Inorg. Nucl. Chem. Lett., 3: 373-81(Sept. 1967).

The preferential extraction of rare earths that possess 2^+ valence into alkali metal amalgams is well known, including the transfer of these elements into amalgams by electrolysis of water solutions containing alkali metals, acetates, and citrates. The first application to the actinides was recently reported. Some studies indicating the possibility of high preferential extraction of Cf, Es, and Fm into sodium amalgam, and the possibility of electrolytic separation of these elements on a mercury cathode, while Pu, Am, Cm, and Bk remain for the most part in the original solution are described. Details are given of the experimental procedures, and results are discussed, particularly with reference to the corresponding rare earths. Berkelium was the least extracted of the actinides tested. (UK)

43035 RECENT DEVELOPMENTS OF ANALYSIS AND SEPARATION OF RARE EARTH ELEMENTS. II. OUTLINE OF THE SEPARATION FOR RARE EARTH ELEMENTS. Kaneko, Keiji; Okada, Hiroko. Denki Shikensho Iho, 29: 180-6(1965). (In Japanese).

Recent development in the determination of rare earth elements has been reviewed with an emphasis on such separation as requires advanced techniques in their preparing process as well as analytical process. About 500 reports on the separation of rare earth elements extracted from chemical journals are classified as in the previous paper (Bull. Electrotech. Lab., 29, 172-9(1965)), and recent tendencies of the separation are described. (Sum. Rep. Electrotech. Lab. (Tokyo) No. 20, 1965).

43036 EXTRACTION OF NITRIC ACID AND URANYL NITRATE WITH TRI-n-OCTYLAMINE. Tsujino, Takeshi; Ohwada, Ken (Japan Atomic Energy Research Inst., Tokyo). Kogyo Kagaku Zasshi, 70: 622-8(Apr. 1967). (In Japanese).

Extraction of HNO_3 and uranyl nitrate with tri-n-octylamine-kerosene was investigated to clarify the extraction mechanism at 30°C. The following extraction reactions were proposed from the extraction equilibrium data and the absorption spectra obtained: for HNO_3 extraction, $R_3N + H^+ + NO_3^- \rightleftharpoons R_3NHNO_3$ and $R_3NHNO_3 + aHNO_3 \rightleftharpoons R_3NHNO_3 \cdot aHNO_3$. The overall distribution ratio (K_d) covering these two equations is shown by the following empirical equation: $K_d = [R_3N]_i^{\frac{1}{2}}/\{[HNO_3]_{aq} + K\}$. The empirical constant (K) was found to be 0, 0.3, and 0.34 under the conditions of $[R_3N]_i < [HNO_3]_{aq} < 1\underline{N}$, $1\underline{N} \leq [HNO_3]_{aq} < 5\underline{N}$, and $5\underline{N} \leq [HNO_3]_{aq} \leq 9\underline{N}$, respectively. U extraction probably proceeds predominantly by the association reaction $R_3NHNO_3 + UO_2(NO_3)_2 \rightleftharpoons R_3NHUO_2(NO_3)_3$ at concentrations of HNO_3 lower than $6\underline{N}$ and by both the association and the ion exchange reaction $R_3NHNO_3 + UO_2(NO_3)_3 \rightleftharpoons R_3NHUO_2(NO_3)_3 + NO_3^-$ at concentrations > $6\underline{N}$ HNO_3. (NSA of Japan)

43037 STUDY AND SEPARATION OF RUTHENIUM AND NITROSYLRUTHENIUM RADIOCOLLOID BY THE METHOD OF ULTRAFILTRATION, CENTRIFUGATION, AND ADSORPTION. Kepak, F.; Kanka, J. (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Int. J. Appl. Radiat. Isotop., 18: 673-80(Oct. 1967).

Many radioelements may exist in aqueous solutions in the colloid state and in connection with their separation it is important to know the conditions under which the radiocolloid is formed. The conditions of the formation of a radiocolloid from ruthenium (III)- and nitrosylruthenium (II)-ions containing ^{106}Ru were studied. The colloid formed was separated by ultrafiltration, centrifugation, and adsorption. It was found that besides a true radiocolloid, the solution also contained a non-true radiocolloid of ruthenium and nitrosylruthenium, formed by adsorption of the radioactive component on foreign particles. The most efficient separation of ruthenium and nitrosylruthenium was achieved by adsorption on ferrous hydroxide. (auth) (UK)

43038 EXTRACTION OF RADIUM, ACTINIUM, AND PENTAVALENT PROTACTINIUM WITH 8-HYDROXYQUINOLINE. Keller, C.; Mosdzelewski, K. (Technische Hochschule, Karlsruhe, Ger. Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). Radiochim. Acta, 7: 185-8(Aug. 1967). (In German).

The complex formation of tracer amounts of Ra(II), Ac(III), and Pa(V) with 8-hydroxyquinoline (Oxin = HOX) was studied by means of extraction into $CHCl_3$. Radium, which was extracted as $Ra(OX)_2 \cdot 4HOX$, formed weaker complexes than the alkaline earth metals of lower atomic number. Therefore a higher concentration of oxin and oxinate was necessary for the extraction of Ra. Actinium was extracted like Am(III) and Cm(III) as $Ac(OX)_2Y$, Y probably being OH^-. The extraction behavior of Pa(V) could be studied reproducibly only by back-extraction, because Pa(V) hydrolyzed and formed radiocolloids very easily. Pa formed a complex compound with 8-hydroxyquinoline, the average composition being $H_2[Pa(OH)_{4.5}(OX)_{2.5}]$. The decreasing distribution coefficient of this chelate complex in the alkaline region showed that the extractable species is a dibasic acid. The 50% extraction of Ra with 1 $\underline{M}$ HOX/$CHCl_3$ was achieved at p_H 10.76, the one of Ac with 0.1 $\underline{M}$ HOX/$CHCl_3$ was reached at p_H 6.62 and the one of Pa with 0.1 $\underline{M}$ HOX/$CHCl_3$ at p_H 1.35 and p_H 11.48. (auth)

43039 SEPARATION OF CARRIER-FREE ^{32}P FROM ELEMENTARY SULFUR ON AN ACTIVE CARBON COLUMN. Bebesel, P. I. Turcanu, C. N. (Inst. of Atomic Physics, Bucharest). Radiochim Acta, 7: 210-12(Aug. 1967).

The separation of carrier-free ^{32}P from elementary sulfur on active carbon has been investigated. The radiophosphorus is adsorbed almost completely (99.5%) and the adsorbtion is not dependent on the quantity of the sulfur dissolved, which varied from 15 up 100 mg/ml. The most suitable eluent for the desorbtion of ^{32}P was found to be nitric acid. The efficiency of the desorbtion and its dependence on the concentration of nitric acid has been studied. The results indicate the possibility of a new method for the preparation of carrier-free phosphorus-32. (auth)

43040 PROCESS FOR THE REPROCESSING OF IRRADIATED COMPACT FUELS BY FLUORINATION. Pierini, G.; Francesconi, A.; Schmets, J. (to U. S. Atomic Energy Commission). U. S. Patent 3,340,019. Sept. 5, 1967.

A fluorination process is described for the conversion of compact nuclear fuels composed of UO_2 into UF_6 by reacting the fuel with a mixture of ClF_3, F_2, and N_2. (AEC)

43041 RECOVERING STRONTIUM FROM REACTOR FUEL REPROCESSING SOLUTIONS AS STRONTIUM SULFATE. Bray, Lane A. (to U. S. Atomic Energy Commission). U. S. Patent 3,343,914. Sept. 26, 1967.

A method for recovering Sr from reactor fuel reprocessing solutions consists of neutralizing the solution to a pH of 0.5 to 2.0, increasing the SO_4^{2-} content to ~1$\underline{M}$, diluting the solution with water to prevent precipitation of Fe and adding $Pb(NO_3)_2$ to form a precipitate of Pb and Sr sulfate, which may then be separated from the solution. (AEC)

43042 SELECTIVE DECLADDING OF NUCLEAR FUEL ELEMENTS. Alfredson, Peter G.; Anastasia, Louis J.; Steindler, Martin J. (to U. S. Atomic Energy Commission). U. S. Patent 3,343,924. Sept. 26, 1967.

A process was developed for selectively removing the stainless steel or Zircaloy cladding from an oxidic fuel by reacting the fuel assembly with a gas mixture of Hf and O_2 in a 2:1 volume ratio. (AEC)

43043 SEPARATION OF URANIUM FROM URANIUM DIOXIDE-ZIRCONIUM DIOXIDE MIXTURES. Newby, Billie J. (to U. S. Atomic Energy Commission). U. S. Patent 3,341,304. Sept. 12, 1967.

A method is described of separating U from mixtures of UO_2 and ZrO_2 by reacting the dioxide mixture with boiling concentrated HF or acid mixtures containing boiling concentrated HF and at least catalytic amounts of Cu and/or Ni ions. The zirconium is dissolved and the uranium remains as solid, hydrated UF_4. (AEC)

43044 PROCESS FOR THE PURIFICATION OF NUCLEAR FUELS. Avogadro, Alessandro; Krawczynski, Stefan (to European Atomic Energy Community. British Patent 1,084,340. Sept. 20, 1967. Filed Dec. 19, 1963.

A process was developed for purification of uranium oxide fuel in which the oxide is halogenated and suspended in molten alkali metal salts. Uranium oxide is precipitated from this melt by reduction of the halogenation product in two or more steps in which the fractions precipitated by successive steps are separated from one another. (M.C.G.)

43045 EXTRACTION OF PLUTONIUM AND NEPTUNIUM FROM AQUEOUS SOLUTIONS. Schulz, Wallace W. (to U. S. Atomic Energy Commission). U. S. Patent 3,346,345. Oct. 10, 1967.

A method is presented of co-extracting plutonium and neptunium values from aqueous acidic waste solutions by adding hydrazine to the waste solution, at room temperature, to selectively reduce the neptunium to the tetravalent state, contacting the aqueous solution with an organic, water-immiscible solution of tridodecylamine whereby neptunium and plutonium are taken up by the organic phase, separating the organic phase from the aqueous phase, contacting the organic phase containing the neptunium and plutonium with an aqueous hydroxylamine sulfate stripping solution, so that the neptunium and plutonium values are taken up by the stripping solution. The tridodecylamine solution can then be recycled a number of times into new batches of hydrazine-reduced aqueous waste solutions. (AEC)

EARTH SCIENCES

Geology

Refer also to abstracts 42964, 43079, and 43080.

43046 (AD-651495) ENVIRONMENTAL RADIOACTIVITY MEASUREMENTS IN THE PICATINNY ARSENAL AREA, 1963-1966. Helf, Samuel (Picatinny Arsenal, Dover, N. J. Feltman Research Labs.). May 1967. 24p. (PA-TR-3516). CFSTI.

An environmental radioactivity analysis program was conducted on samples taken from Picatinny Arsenal and surrounding areas. The period covered was from the spring of 1963 to the fall of 1966. Samples of grass, leaves, river and lake water, mud, and precipitation were assayed during 1963 and 1964. The most extensive sampling was done on soil from wooded areas. Samples of such soil were analyzed from November 1963 to October 1966. Radioassay was performed for the presence and specific concentration of individual gamma ray emitters by gamma ray spectrometry. Resolution of the complex spectrum for individual radionuclides was accomplished by electronic computer methods. The presence of five distinct gamma emitters was observed in almost all samples in concentrations from 1 to 100 picocuries of individual nuclide per gram of sample. These radioisotopes and their respective half-lives are cerium-144 (285 days), antimony-125 (2.7 years), ruthenium-106 (1.0 year), cesium-137 (30 years), and manganese-54 (314 days). The origin of these radionuclides in the local environment is principally from aged nuclear fallout products resulting from atmospheric tests conducted by the U. S. and Soviet Russia in the fall of 1962. Zirconium-95 (65 days) was observed in some of the earlier samples and again at barely detectable levels in the most recent soil samples. The reappearance of this short-lived radionuclide is presumed to be due to Chinese nuclear explosions. Naturally occurring potassium-40 was also detected in almost all samples. No radioactivity was detectable whose origin can be attributed to local sources, i.e., to Picatinny Arsenal operations. (auth) (TAB)

43047 (AECL-2753) A PROGRAM TO SURVEY CANADIAN DEUTERIUM SOURCES. Bancroft, A. R.; Brown, R. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). July 1967. 15p. Dep. CFSTI. CAN $0.50.

A survey is underway of the two major Canadian sources of deuterium, water and natural gas. The geographical and seasonal variations of water deuterium concentrations will be studied over a two-year period by sampling oceans, surface waters and precipitation at about one hundred locations. Natural gas from about twenty major Alberta fields will be analyzed and, where possible, the deuterium content of the water and hydrogen sulfide fractions will be related to that of the methane. The incentive for this survey is to provide information for siting future heavy water production plants. However, the data should be of great value in studying the meteorological and hydrological phenomena which establish these concentrations. This, in turn, will be of value in estimating concentrations at sites that have not been included in this survey. (auth)

43048 (CU-2663-8, App.Q) CHEMICAL AND ISOTOPIC BALANCES FOR A MEROMICTIC LAKE. Broecker, Wallace, Takahashi, Taro; Li, Yuan Hui; Thurber, David. 64p.

The unusual chemical properties of the water of two lakes in Green Lakes State Park, Fayetteville, N. Y., i.e. permanent chemical and thermal stratification of the water, $CaCO_3$ formations on the shore, and high concentration of H_2S in deep water, were investigated to establish a hydrologic model for the lakes, and to interpret the chemical processes taking place. The methods used for sampling and analyzing the waters and for estimating the sediment accumulation rate are described. The results of the analyses are given. It was concluded that the permanent stratification of the lake waters is the result of a salinity difference between waters entering the deep and surface layers of the lakes. (L.C.L.)

43049 A TECHNIQUE FOR DIGITAL COMPUTER PROCESSING OF DATA FROM RADIOISOTOPE SEDIMENT TRACING STUDIES. Hartley, P. E. (Australian Atomic Energy Commission, Lucas Heights, New South Wales). Int. J. Appl. Radiat. Isotop., 18: 713-20(Oct. 1967).

A simpler computer technique for directly producing isoactivity contour maps from data obtained from radioisotope sediment tracing experiments is described. The method is used to process sets of readings of counting rate, position and time, taken at many points which are not necessarily on a regularly spaced grid. A FORTRAN program using this method has been written for an IBM 7040 computer and tested on results from a silt tracing experiment in Botany Bay, Australia. The technique could be adapted to radioisotope water tracing experiments and also meteorological, oceanographic and other geophysical investigations. (UK)

43050 SHEAR STRENGTH AND WEAKENING OF ZEOLITIZED TUFFS FROM THE NEVADA TEST SITE, NEVADA. Riecker, Robert E.; Rooney, Thomas P. (Air Force Cambridge Research Labs., Bedford, Mass.). Amer. Mineral., 52: 1174-8(July-Aug. 1967).

Experimental shear deformation of Tertiary zeolitized tuffs has demonstrated weakening of 43 to 63% at temperatures between 27°C and 500°C. Tests were made to pressures of 60 kilobars, temperatures to 900°C, and at a constant strain rate of 10/sec. Weakening probably results from dehydration of clinoptilolite. Dehydration reduces effective confining pressure by increasing pore pressure. (auth)

43051 NUCLEAR REACTIONS IN TELLUROBISMUTHITE. Gerling, E. K.; Shukolyukov, Yu. A.; Ashkinadze, G. Sh.; Komarov, A. N. (Lab. of Geology of the Precambrian, Leningrad). Geokhimiya, No. 9, 1038-48(Sept. 1967). (In Russian).

The Xe content in tellurobismuthite from Boliden (Sweden) was determined to be $156 \cdot 10^{12}$ cm^3/g. Three components were found by calculation: aerial Xe, Xe of uranium fission, and excess Xe. It is inadmissible to normalize the isotopic composition according to ^{132}Xe because a part of the amount of this isotope formed during uranium fission. Gas fractions that were isolated from tellurobismuthite at different temperatures from 100 to 1100° have been analyzed. A correlation between ^{130}Xe, ^{131}Xe, ^{129}Xe was observed. For ^{128}Xe the spread of points was greater; the excess did not show any correlation with other isotopes. The activation energy of isotope isolation was such that even at low temperatures the tellurobismuthite lost 90 percent of xenon having been formed in its structure. The rate constant of double beta-decay of ^{130}Te was $(2.3 \pm 0.3) \cdot 10^{-21}$ year^{-1} with regard for losses. (auth)

43052 EVOLUTION MODEL OF THE FORMATION OF ORE LEAD ISOTOPIC COMPOSITION. Tarasov, L. S.; Zykov, S. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 9, 1019-36(Sept. 1967). (In Russian).

It is shown that Houterman's model of isochrones leads to errors in interpreting data on the isotopic composition of leads and in determining the absolute age. They arise because this model does not take into account the real processes of multistage differentiation in the crust of the Earth. The peculiarities of the regional variations in the isotopic composition of ore leads such as approximate parallelism of the axes of regional isotope contours, the magnitude of their inclination and others, lead to a principal scheme of the formation model of isotopic lead composition being based on the idea about a multistage differentiation which is accompanied by changes of the U/Pb ratio in the depths of the Earth. (auth)

Meteorology

Refer also to abstracts 43012, 43046, and 43112.

43053 (AECL-2696) MONITORING OF RADIOACTIVE NOBLE GASES IN AIR. Merritt, W. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). June 1967. 10p. Dep. CFSTI. CAN $0.50.

The radioactive noble gas content (Ar-41, Xe-133, Xe-135) of 400 l air samples collected in meteorological balloons was measured by γ-ray spectrometry. Particulates and volatiles were removed by a filter and a bed of activated charcoal in the sample line. The balloons were placed over a 7.6 cm × 7.6 cm NaI(Tl) crystal inside a large lead castle (76 cm × 76 cm × 76 cm) with 10 cm of shielding on all sides. The apparatus was calibrated with gas samples that had been assayed by absolute counting techniques. Ar-41 was compared with Co-60 in a high pressure 4π ionization chamber. Xe-133 and Xe-135 were separated from irradiated xenon in a mass separator and assayed by internal gas proportional counting. The counting efficiency of the crystal with varying volumes of gas in the balloons was measured and optimum conditions were selected. Efficiencies were Ar-41-0.11%, Xe-133-0.12%, Xe-135-0.46%. Measurable concentrations were Ar-41-3.5×10^{-9} μCi/cm^3, Xe-133 4.2×10^{-8} μCi/c/n^3 and Xe-135 8×10^{-9}

$\mu Ci/cm^3$, i.e., two orders of magnitude below the MPC_a as set by the ICRP. (auth)

43054 (COO-1199-13) TIME DISTRIBUTIONS OF RADIOACTIVITY AND CHEMICAL CONSTITUENTS IN RAINFALL. Huff, F. A.; Stout, G. E. (Illinois State Water Survey, Urbana). [1967]. 11p. (CONF-670931-13). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

The relation between the time distributions of radioactivity and selected chemical constituents in rainwater in midwestern USA is being investigated through comparisons between concentrations of gross beta and Na, K, Ca, and Mg in convective rainstorms. Chemical element concentrations are obtained with a Beckman atomic absorption spectrophotometer and beta counting is made with standard equipment. The data were obtained from a network of automatic rainwater samplers. Experimental results indicate the lower troposphere is a major source of radioactivity input to convective storms, as opposed to direct input from the stratospheric reservoir of radioactive debris. Since soil material and man-made atmospheric pollution are the primary sources of the above elements in continental regions, the time distribution comparisons could provide further information on the radioactivity input mechanism in rainstorms. In 5 cases analyzed to date, similar characteristics have been found, in general, between the time distributions of beta concentration and the chemical elements suggesting similar source regions and lending further support to the theory that the major input of radioactive particulates in convective storms occurs at low levels. (auth)

43055 (DPST-67-30-2) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, January-June 1967. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 1967. Contract AT(07-2)-1. 18p. Dep. CFSTI.

The results of the environmental monitoring program for the atmosphere, vegetation, milk, and water near the Savannah River Plant (SRP) for the period January 1 through June 30, 1967, are presented. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by worldwide fallout from nuclear weapons testing. Beta activity in air, which showed no relationship with plant operations, was about the same as that observed for the same period of 1966. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of radionuclides in river water at Highway 301 did not exceed 1.2% of the Maximum Permissible Concentrations. (L.C.L.)

43056 (EUR-3554e) ENVIRONMENTAL RADIOACTIVITY, ISPRA, 1966. de Bortoli, M.; Gaglione, P.; Malvicini, A. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). May 30, 1967. 70p. Dep.

Measurements of environmental radioactivity performed during 1966 by the site survey group of the Protection Service are described. Data are given on the concentrations of strontium-90, cesium-137 and other radionuclides in fallout, air, soil, waters, herbage, animal bones and foods. (auth)

43057 (HASL-183) FALLOUT PROGRAM. Quarterly Summary Report, June 1-September 1, 1967. Hardy, Edward P. Jr.; Rivera, Joseph (New York Operations Office (AEC), N. Y. Health and Safety Lab.). Oct. 1, 1967. 161p. Dep. CFSTI.

Current data are presented from the HASL Fallout Program, Isotopes, Inc., Argonne National Laboratory, Euratom Joint Nuclear Research Center, National Radiation Laboratory in New Zealand, Department of Scientific and Industrial Research in New Zealand, USDA Soil Conservation Service, and the Argentine Atomic Energy Commission. Radionuclide levels in stratospheric air, surface air, fallout, milk, other diet components, and tap water, are given in tabular form. The initial section consists of interpretive reports and notes covering the following topics: global deposition of Sr-90 through 1966; the Sr-89/Sr-90 ratio in monthly fallout; depth of penetration of Sr-90 and Cs-137 in soil; Sr-90 levels in the diets and bones of children in Argentina; and radioactivity in the stratosphere in August 1967. A bibliography of recent publications related to radionuclide studies is also presented. (auth)

43058 (LA-3663) BETA RADIOACTIVITY IN ENVIRONMENTAL AIR AND PRECIPITATION AT LOS ALAMOS, NEW MEXICO, FOR 1966. Kennedy, W. R.; Aeby, Jack W. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Beta activity of particulate matter in both air and precipitation for 1966 are reported for Los Alamos, New Mexico. The decline in activities that began in the last half of 1963 continued until the middle of 1966. Increases in May, November, and December can perhaps be attributed to the Chinese atmospheric tests. (auth)

43059 (ORNL-TM-1970) NUMERICAL SOLUTION OF THE ISOTHERMAL FISSION-PRODUCT DEPOSITION EQUATIONS: THE PROGRAM PREDEP-II. Kress, T. S.; Nelson, Paul Jr. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 28p. Dep. CFSTI.

The heat-mass analogy was previously used to develop a semilinear system of partial differential equations to describe the isothermal deposition of fission products. This system is transformed into a system of integral equations in computationally convenient variables, and a finite-difference method for the solution of the integral equation system is described. A brief description is given of the computer program PREDEP-II, which accepts data in terms of physically convenient dimensionless variables, transforms these to the computational variables for means of solving the finite-difference equations, and finally reports the results in terms of the physical variables. (auth)

43060 (SC-DC-67-1866) INVESTIGATION OF TMAE (TETRAKIS (DIMETHYLAMINO) ETHYLENE), A CHEMILUMINESCENT MATERIAL, AS AN ATMOSPHERIC TRACER. Smith, R. E.; Elrick, R. M. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 14p. (CONF-670931-12). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

TMAE (Tammy) was investigated for use as an atmospheric tracer. Small quantities of TMAE released in the troposphere at Sandia's Tonopah Test Range produced a chemiluminescent cloud whose image was recorded by a light-sensitive TV tracking system. Experiments are described that were conducted primarily to determine the feasibility of using TMAE as a tracer material in field experiments to verify the accuracy of a diffusion and fallout model. It was concluded that TMAE can be used to provide much needed data on the effect of turbulent diffusivities and other meteorological parameters involved in dispersing a cloud of particles and to obtain quantitative information about the ground dispersion pattern which results from the point source release in the troposphere and lower stratosphere of particles 100 to 200 μ in dia. (auth)

43061 (UCRL-70540) ATMOSPHERIC DIFFUSION OF LARGE CLOUDS. Crawford, Todd V. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 12, 1967. Contract W-7405-eng-48. 29p. (CONF-670931-11). Dep. CFSTI.

From USAEC Meteorological Information Meeting, Chalk River, Ontario, Canada.

Clouds of pollutants travel within a coordinate system that is fixed to the earth's surface, and they diffuse and grow within a coordinate system fixed to the cloud's center. An approach is discussed for predicting the cloud's properties, within the latter coordinate system, on space scales of a few hundred meters to a few hundred kilometers and for time periods of a few days. A numerical cloud diffusion model is presented which starts with a cloud placed arbitrarily within the troposphere. Similarity theories at atmospheric turbulence are used to predict the horizontal diffusivity as a function of initial cloud size, turbulent atmospheric dissipation, and time. Vertical diffusivity is input as a function of time and height. Diurnal variations of turbulent diffusion in the boundary layer and effects of temperature inversions, etc. can be modeled. Nondiffusive cloud depletion mechanisms, such as dry deposition, washout, and radioactive decay, are also a part of this numerical model. An effluent cloud, produced by a reactor run at the Nuclear Rocket Development Station, Nevada, is discussed. Measurements on this cloud, for a period of two days, are compared to calculations with the above numerical cloud diffusion model. In general, there is agreement, within a factor of two, for airborne concentrations, cloud horizontal area, surface air concentrations, and dry deposition as airborne concentration decreased by seven orders of magnitude during the two-day period. (auth)

43062 CURRENT RESEARCH ON AEROSOLS AT PACIFIC NORTHWEST LABORATORY. Postma, A. K.; Schwendiman, L. C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. J. Air Pollut. Contr. Ass., 17: 599-602(Sept. 1967).

Brief summaries are given of current research on aerosols at the Pacific Northwest Laboratory. These include studies of the deposition, flow patterns, precipitation, and inhalation of particles in gases and in the atmosphere, and aerosol research related to nuclear safety. (L.C.L.)

43063 ^{141}Ce AND ^{144}Ce IN GROUND LEVEL AIR AT BOMBAY. Joshi, L. U.; Mahadevan, T. N. (Bhabha Atomic Re-

search Centre, Bombay). J. Sci. Ind. Res., 26: 198-200(May 1967).

Ground level air at Bombay, India, was monitored from November 1961 to July 1965. The radioactivity resulting from ^{141}Ce and ^{144}Ce in ground level air was measured and tabulated. The test data were correlated with nuclear weapons tests in the Arctic and Pacific areas. (L.C.L.)

43064 TURBULENT EFFECTS IN THE FORMATION OF BUOYANT VORTEX RINGS. Fohl, Timothy (Mt. Auburn Research Associates, Inc., Cambridge, Mass.). J. Appl. Phys., 38: 4097-8(Sept. 1967).

The process in which a mass of buoyant fluid released from rest forms a buoyant vortex ring is discussed. The theory of buoyant vortex rings is useful in interpreting the motion of a very bouyant fluid such as those encountered in atmospheric nuclear tests. (L.C.L.)

43065 USE OF RADIOACTIVE TRACERS IN STUDYING MASS TRANSFER IN THE ATMOSPHERIC BOUNDARY LAYER. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Munn, R. E. Phys. Fluids, Suppl., S263-6(1967).

Natural surfaces such as snow act as almost perfect sinks for radioactive gases. Experiments are described in which tracers of differing molecular diffusivities are released simultaneously permitting interferences to be drawn about the function of the lowest few millimeters of the atmosphere in regulating vertical fluxes. The results of tracer field experiments at Chalk River, Canada, are described, and the implications are discussed. (auth)

43066 EVALUATION OF THE METHODS FOR DETERMINING THE RADIOACTIVE POLLUTION OF THE ATMOSPHERE BASED ON VARIOUS FILTRATION TECHNIQUES. Piatkowski, Adam. Warsaw, Warsaw Polytechnic Inst., 1965. (In Polish). Thesis.

A discussion of the general state of research in the field of radioactive atmospheric pollution and the physical aspects of filtration through filter paper is presented. Some of the known methods of measuring the radioactivity of air are described. Electrofilters made at the Department of Radiology and the conclusions drawn from investigations on the efficiency of electrofilter filtration as a function of the air flow rate, current intensity in corona discharge, voltage, and the shape of voltage characteristic are discussed. A method of determining radioactive pollution of air, including the measuring apparatus, experimental data obtained using the method and a discussion of the method and the results are given. (JPRS)

Mineralogy

43067 (EUR-3481.e) SOME GEOLOGIC CONCEPTS AS A GUIDE FOR THE SEARCH OF URANIUM IN THE PRECAMBRIAN SHIELDS. Van Wambeke, L. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Mar. 20, 1967. 63p. Dep.

The distribution pattern of uranium occurrences in the Precambrian shields can be explained mainly on the basis of the geological and paleogeographical evolution of sedimentary basins which are either intracratonic or geosynclinal. In intracratonic basins, uranium occurs either in sediments, in acid/intermediate volcanics or in veins and is essentially located in the marginal zones of the basins and in the neighbouring basement. Favorable areas for uranium are mainly confined to these marginal zones of sedimentation and attention must be focused especially on intracratonic basins either containing interbedded acid/intermediate volcanics in the stratigraphic series or formed by intense fracturing of the basement. In geosynclines, the distribution of uranium occurrences is more complicated because these basins have been affected during the orogenies by magmatic-hydrothermal activity and metamorphism. However, a relationship also seems to exist between the location of uranium deposits and marginal zones of sedimentation. This feature is not only valid for uranium mineralizations in sediments but may explain uranium occurrences such as veins and pyrometasomatic deposits. The distribution of uranium occurrences related to post-Caledonian events in the shields' areas is also discussed. Geological criteria which may be used for a preliminary evaluation of the uranium outlook in the Precambrian belts are described. Examples of poor or unprospected areas apparently favorable for uranium are given. Application of geologic concepts is an important step for the choice of the most promising areas to be prospected for uranium. (auth)

43068 (AEC-tr-6903) NOMOGRAMS FOR THE CALCULATION OF THE CONCENTRATION OF RADIOACTIVE ELEMENTS IN ROCKS. Matveev, A. B. Translated from Vop. Rud. Geofiz., Gos. Geol. Kom. SSSR, No. 5, 131-3(1965). 4p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Nomograms are proposed to shorten calculations and to lower the number of mistakes made in determining the concentrations of radioactive elements in rocks using gamma spectrographic data from geological surveys. Methods for use of nomograms are given. Radium concentrations are expressed in equivalent of uranium. (F.S.)

Oceanography

43069 (CU-2663-8) MIXING, DIFFUSION, AND CIRCULATION RATES IN OCEAN WATERS. Annual Progress Report No. 8. (Columbia Univ., Palisades, N. Y. Lamont Geological Observatory). June 1967. Contract AT(30-1)-2663. 500p. Dep. CFSTI.

A summary of work in the physical oceanography program for 1966 to 1967 is presented. Twenty-three papers on the mixing, diffusion, and circulation rates in ocean waters are also presented. Separate abstracts were prepared for four papers. (L.C.L.)

For abstracts of individual papers see: 43048 and 43070-43072.

43070 (CU-2663-8, App.R) ^{226}Ra AND ^{222}Rn CONCENTRATION IN ATLANTIC AND PACIFIC OCEANS. Broecker, W. S.; Li, Y. H.; Cromwell, J. 20p.

Measurements of ^{222}Rn in sea water suggest: (1) that the ^{226}Ra concentration in the surface north Atlantic and surface north and equatorial Pacific Oceans are uniformly close to about 4×10^{-14} gm ^{226}Ra/liter, (2) that the deep Pacific has a four times higher and the deep Atlantic a two times higher ^{226}Ra concentration than surface water. These enrichments can be explained by ^{226}Ra influx from deep sea sediments and an ocean-wide ^{226}Ra particulate settling rate of 2.4×10^{-14} gm/cm^2 yr., (3) the vertical distribution of ^{222}Rn deficiency in the surface northwest Pacific Ocean suggests a coefficient of vertical eddy diffusion between 30 and 300 cm^2/sec and a gas exchange rate in surface water between 8 and 80 moles CO_2/m^2 yr., and (4) the vertical profile of ^{222}Rn excess in near bottom water of the south Atlantic gives a coefficient of vertical eddy diffusion of 1.5 more than 30 cm^2/sec. (auth)

43071 (CU-2663-8, App.S) RADIOCARBON AND ^{137}Cs IN THE ARCTIC OCEAN. Thurber, David L. 5p.

The circulation patterns and residence time of water in the Arctic Ocean were studied by making radiocarbon, ^{137}Cs, and ^{90}Sr analyses. Results of the analyses were compared with Pacific Ocean and Atlantic Ocean water data. (L.C.L.)

43072 (CU-2663-8, App.T) ^{14}C, ^{137}Cs, AND ^{90}Sr PROFILES IN ANTARCTIC WATERS. Mathieu, Guy G. (Columbia Univ., New York). 25p. Thesis.

Measurements of radiocarbon, cesium 137, and strontium 90 were compared with standard hydrographic information in three localities in the southern ocean. The results are in agreement with previous interpretations of the directions of water movement and show potential for determining rates of water movement in both vertical and horizontal directions. The data are presently insufficient for strong conclusions to be drawn, but a detailed study, patterned after this one, should be fruitful. (auth)

43073 RESTRICTED DISPERSION OF ^{95}Zr AND OF ^{95}Nb AFTER RELEASE TO THE SEA IN NUCLEAR FUEL REPROCESSING EFFLUENT. Hampson, B. L. (Ministry of Agriculture, Fisheries, and Food, Lowestoft, Eng.). Health Phys., 13: 1093-1103(Oct. 1967).

The manner of dispersion of the three nuclides ^{95}Zr, ^{95}Nb, and ^{106}Ru, after their release to sea through an effluent pipeline, was studied under identical conditions. Porphyra umbilicalis, which was sampled at varying distances along the shore for 25 miles from the release locality, was used as indicator organism, so as to integrate short-period fluctuations in the seawater concentrations of the nuclides. It was found that the dispersion of ^{95}Nb and of ^{95}Zr was restricted compared with that of ^{106}Ru. Apparently the rate of removal of the former nuclides from the seawater to the sea bed by chemical processes was greater than the rate of mixing of the immediate pool of seawater around the release point with that in more distant regions. Measurement was made of the extent of concentration of ^{95}Zr and of ^{95}Nb from seawater by Porphyra living under natural conditions in two different localities, the Pentland Firth and the Irish Sea. (auth) (UK)

43074 VERTICAL DISTRIBUTION OF ^{90}Sr, ^{144}Ce, ^{147}Pm, AND ^{155}Eu IN COASTAL MARINE SEDIMENTS. Cerrai, E. (Laboratori CISE, Milan); Schreiber, B.; Triulzi, C. Energ. Nucl. (Milan), 14: 586-92(Oct. 1967).

The vertical distribution of the content of ^{90}Sr, ^{144}Ce, ^{147}Pm, and

^{155}Eu in coastal sediment samples of the Ligurian Sea is reported. Ten subsequent 2-cm thick fractions were analyzed beginning from the top of the cores. Such fractions derive from the blending of the corresponding 7-core fractions collected at 50 m depth. The chemical and radiochemical procedures used are described for the separation of strontium and rare earths, both contained in an acidic extract. Particular care was taken during processing and measurements, owing to the small activities involved. Radioactivity deposited on the bottom results to be, in pCi/cm^2, 0.298 for ^{90}Sr, 10.9 for ^{144}Ce, 15.99 for ^{147}Pm, and 1.81 for ^{155}Eu. (auth)

Seismology

43075 (AD–651653) LARGE-APERTURE SEISMIC ARRAYS. Quarterly Technical Report. Report No. 3. (General Atronics Corp., Philadelphia, Pa.). Mar. 1967. Contract AF19(628)-5981. 60p. (ESD-TR–67-282). CFSTI.

Progress is reported on preliminary results on spectral estimates of seismic events and two principal conclusions are suggested: noise prediction is probably not a useful means of reducing the variability of spectral estimates, and, for the one large surface-focus event processed to date, there is a significant amount of signal energy above 4 Hz. The problem of detecting nuclear explosions in the presence of large natural events has also been considered during this period. This problem is discussed here, with the emphasis on the possibility of steering nulls at the natural events. Difficulties resulting from the sampled nature of the seismic records and from coda reverberations are also discussed in this context. Finally, the location of epicenters by beam splitting with a LASA is discussed. The technique is described, the sources of error are analyzed, and data from three seismic events are presented. (auth) (TAB)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 43064 and 43091.

43076 (AD-645179) MOTION OF SUBSURFACE SOIL INCLUSIONS SUBJECTED TO SURFACE BLAST LOADING: RESULTS OF SERIES III TESTS. White, Charles R. (Naval Civil Engineering Lab., Port Hueneme, Calif.). Jan. 1967. 36p. CFSTI.

Experiments were conducted in June 1965 to extend fundamental knowledge of differential motions of buried inclusions and soil when the soil is subjected to surface blast loadings. Four inclusions of two masses buried at two depths in dry sand were subjected to surface blast pressures from 4 to 250 psi. The heavier masses displaced farther than either the lighter masses or the soil but the soil displaced farther than the lighter mass at the shallower depth. The density of the soil was intermediate between the densities of the two inclusion masses. (auth) (TAB)

43077 (AD-651454) EFFECTS OF NUCLEAR ATTACK ON FREIGHT TRANSPORTATION SYSTEMS: INTERACTIONS AND COMPARISONS AMONG MODES. Final Report. Dixon, Harvey L.; Tebben, Thomas H. (Stanford Research Inst., Menlo Park, Calif.). Mar. 1967. Contract OCD-PS-64-201. 55p. CFSTI.

The operations and equipment used in transferring vehicle loads between two vehicles or between a vehicle and a terminal are examined for seven different classes of cargo. For each of these classes, the usual method of load transfer is discussed, and expedient methods that could be used in a postattack situation are suggested. St. Louis, Missouri, is used to illustrate the problem of moving cargo through a damaged area after a nuclear attack. Several alternative methods of moving cargo via multiple transportation modes are analyzed, and a simple procedure for determining the minimum-time route among the alternatives is proposed. The transportation resources required to deliver the minimum supplies for survivor support in the St. Louis area are analyzed for different mixes of trains and trucks and for movements of the supplies over a range of distances. A general summary of the vulnerability of each transportation mode to nuclear attack is provided, and the remedial actions that might be taken in the preattack period to enhance postattack capability are discussed. (auth) (TAB)

43078 (FOA-4-4493-16) KAERNLADDNINGSEXPLOSIONER 1945-1966. (Nuclear Explosions, 1945-1966). Zander, I.; Araskog, R. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). June 1967. 16p. (In Swedish). Dep.

A compilation of all known nuclear explosions between 1945 and 1966 is given. (SWED)

43079 (PNE-3006) TECHNICAL AND ECONOMIC POTENTIALS OF SHALE OIL PRODUCTION BY NUCLEAR EXPLOSIVES. Heiss, Klaus-Peter (Mathematica, Princeton, N. J.). Aug. 31, 1967. Contract AT(04-3)-691. 125p. Dep. CFSTI.

The in situ production of oil from shale by large underground retorts created by nuclear explosives is discussed. The process is described, crude oil and oil shale resources are estimated, and cost estimates of this new technology are compared with present crude oil prices and potential costs of conventional shale oil production. (L.C.L.)

43080 (PNE-3007) ECONOMIC POTENTIALS OF NATURAL GAS PRODUCTION STIMULATION BY NUCLEAR EXPLOSIONS. Heiss, Klaus-Peter (Mathematica, Princeton, N. J.). Aug. 31, 1967. Contract AT(04-3)-691. 61p. Dep. CFSTI.

The technical and economic potentials of gas stimulation by nuclear explosives are described. A sufficiently firm body of information related to gas stimulation exists to confirm the statement that gas stimulation can become one of the first technically and economically feasible applications of the peaceful uses of nuclear explosives. It appears that gas stimulation can be applied with profit in existing tight gas fields which can not be exploited with conventional techniques. If the existing information is confirmed experimentally, the peaceful application of nuclear explosives would increase the United States recoverable natural gas resources by amounts greatly in excess of known supplies. Specifically, it appears that the increase would extend the present supply of gas by adding a supply of at least 18 years. The true figure might in fact exceed 55 years additional supplies, even allowing for a substantial annual increase in demand by the United States economy. (auth)

43081 (UCRL-50008-67-3) PLOWSHARE PROGRAM. VOL. II, NO. 6. Quarterly Report, May 1, 1967-July 31, 1967. Rabb, David D. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). July 31, 1967. Contract W-7405-eng-48. 23p. Dep. CFSTI.

The sloop project feasibility study was completed and accepted. The AEC will direct the detonation and Kennecott the longer term copper leaching phase. Several years will be required to complete the safety studies at the Arizona site. Prospects for an early 1969 shot date are optimistic. A code was developed for predicting the extent of cracking produced in brittle materials such as granite, dolomite, or salt. Gasbuggy studies are proceeding toward a firing date during the second quarter of 1968. Monte Carlo calculations were made to determine the best method of in situ measurements of hydrogen in earth media. Pressure transducers were developed which may be cast in grout. The design of project Bronco for the use of nuclear explosions to break up oil shale deposits for subsequent in situ retorting is discussed. (F.S.)

43082 THE FORMATION, DISTRIBUTION, AND CHARACTERISTICS OF RADIOACTIVE FALLOUT. Crocker, G. R. (Naval Radiological Defense Lab., San Francisco). J. Air Pollut. Contr. Ass., 17: 578-9(Sept. 1967).

The work of the U. S. Naval Radiological Defense Laboratory in studying the formation, distribution, and characteristics of radioactive fallout from nuclear explosions is briefly outlined. (L.C.L.)

43083 INITIAL SHOCK-FRONT INTERACTION WITH SOLID MODELS. Zagieboylo, Walter (Army Natick Labs., Mass.). J. Appl. Phys., 38: 3828-34(Sept. 1967).

The initial response of solid models to low-Mach, high-mass-flow shock waves was analyzed. A rapid-response piezoelectric load cell was mounted in a series assembly behind the models to directly measure resultant loading. The load history was analyzed and correlated with model geometry and shock-wave velocity for rectangular wood models of various length and weight and for the effects caused by changing the front surface material. The front surface of the model was in some cases bare and in other cases covered with plastic foam or thin foam rubber. It was observed that the coatings produced increased loading effects. The maximum loading force was determined for various overpressures and found to be in linear relationship to a dimensionless ratio involving shock-tube and shock-wave pressure parameters. (auth)

Facilities and Equipment

Refer also to abstracts 43016, 43195, 43196, 43942, 43947, 43955, 43976, 43977, 43980-43982, 43995, 44987, 44988, 44991, 45001, 45002, and 45004.

43084 (BNWL-382) WATER FILTRATION RESEARCH, PART II. THE EFFECTS OF BACKWASH WATER TEMPERATURE ON FILTER BED EXPANSION. Touhill, C. J.; Schmidt, R. L.; Carlile, B. L.; Olesen, D. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

A water filtration research program has shown that the bed expansion of Hanford-type filters is influenced by the temperature of backwash water. Empirical equations were derived to relate temperature and bed expansion for various flow rates. A nomograph is included to assist operational personnel in determining optimum backwash rates. (auth)

43085 (CEA-R-3249) FONCTIONNEMENT DU TRANSFORMATEUR A COURANT CONTINU UTILISE EN "POMPE A FLUX." (Operation of a Direct Current Transformer Used as a "Flux Pump"). Deschanels, Jean-Louis (Commissariat à l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1967. 7p. (In French). Dep.

Equations governing the operation of a flux pump with a superconducting transformer are derived. It shows that there exists a limiting value of the current in the charge coil and that the limit is independent of this coil. (auth)

43086 (CONF-671009-1) DUAL TURBOPUMP LIQUID HYDROGEN FEED SYSTEM EXPERIENCE. Gunn, S. V.; Dunn, C. (Rocketdyne, Canoga Park, Calif.). [nd]. Contracts SNP-2; NASw-347; NASw-1210; CTZ-39600-2. 29p. Dep. CFSTI.

From 9th Liquid Propulsion Symposium, St. Louis, Mo.

Experience in the design and development of liquid hydrogen feed systems utilizing two turbopumps operating in parallel is

described. The pumps are supplied with liquid hydrogen from a common inlet and discharge into a common duct; the turbines also are supplied with turbodrive gases from a common inlet. Two system configurations were designed, developed, and delivered; one having dual Mark 9 turbopumps and one having dual Mark 25 turbopumps. The systems deliver flows up to 330 lb/sec and pressures up to 2000 psi. They were developed for use in Phoebus reactor testing performed by the Los Alamos Scientific Laboratory. Component and system performance, and dynamic characteristics of the systems are described. Development tests have proved the practicality of parallel dual, liquid hydrogen turbopump operation. The two units operate with complete hydrodynamic stability, sharing the hydraulic load equally, and no detrimental mechanical interactions have been found. Dual turbopumps offer the potential of emergency, single pump operation. The current feed system has a check valve in each pump discharge prior to the common header, and the potential for such emergency operation is being evaluated. (auth)

43087 (DMSP-G-8) DELFT MOLTEN SALT PROJECT DESIGN SUMMARY REPORT. Latzko, D. G. H.; Deckers, J. A. M.; Kroeckel, H.; de Melker, P.; Spiewakowski, W.; Swart, W. (Technische Hogeschool, Delft (Netherlands)). Aug. 1966. 107p. Dep.

A design study of the Delft Molten Salt Project is described. The installation consists of primary and secondary loops used to develop molten salt technology. The salt in the primary system is a eutectic mixture of fluorides of Li, K, and Na, and the salt in the secondary loop is a eutectic mixture of Na nitrite and Na and K nitrates. Components of the installation including the heat exchangers, heaters, pumps, coolers, freeze valves, dump vessels, instruments, and controls are explained. Auxiliary systems and operating procedures are described. (F.S.)

43088 (IS-T-199) DEVELOPMENT OF A LABORATORY SCALE CONTINUOUS MULTISTAGE EXTRACTOR. Rahn, Richard Walter (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 36p. Dep. CFSTI.

Thesis.

A continuous multistage box-type mixer-settler extractor has been designed, constructed, and operated to study the feasibility of separating the individual rare earths from each other using 1 M di(2-ethylhexyl) phosphoric acid in Amsco Odorless Mineral Spirits as the active solvent and a dilute HCl solution as the heavy phase or scrub solvent. Preliminary results indicate that the extractor operates satisfactorily for this purpose although extensive studies on the influence of operating conditions on stage efficiencies have not been carried out. (auth)

43089 (MSAR-67-149) EFFECT OF HIGH TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Quarterly Progress Report, April-June 1967. (MSA Research Corp., Evans City, Pa.). Aug. 1967. Contract AT(11-1)-765. 22p. Dep. CFSTI.

SODIUM — effect on mechanical properties of stainless steels at 1100°F and 1200°F
LOOPS — design and operation of, study effects of high temperature sodium on mechanical properties of stainless steels
EQUIPMENT AND PROCEDURES — development for testing effects of high temperature sodium on mechanical properties of steels
STAINLESS STEEL — mechanical properties of, effect of high temperature sodium on
REACTORS, FAST — structural materials for, effect of high temperature sodium on mechanical properties of
REACTORS, LIQUID-METAL COOLED, REACTORS, BREEDER — structural materials for, effect of high temperature sodium on mechanical properties of
EXTENSOMETERS — development of high temperature liquid metal environment, to measure specimen strain
STRAIN — measurement under stress, development of extensometer for (R.C.K.)

43090 (ORNL-TM-1922) DEAERATOR EJECTORS AND BLOWERS FOR 50-Mgd AND LARGER DESALINATION PLANTS. Final Report. Jacobs, S. C.; Mitchell, B. E.; Sood, R. K. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 61p. Dep. CFSTI.

In the design and the operation of seawater evaporators, care must be taken to prevent accumulations of noncondensable gases that can blanket condenser surfaces, interfere with efficient heat transfer, and cause corrosion of the evaporator internals. In a 50-Mgd flash evaporator plant which uses acid feed treatment, means must be provided for removing between 108,000 and 263,000 lb/day of gases which contain about 60% water vapor. Flow sheets were prepared for a number of systems containing blowers, ejectors, surface condensers, barometric condensers, and decarbonation ponds. Detailed design calculations were made to determine the functional specifications for each of the components in each system. Cost estimates were evaluated and reconciled to arrive at a reasonable cost basis. Based on these prices and on the Office of Saline Water (OSW) ground rules for utility (steam, electric power) costs, an economic evaluation was made of all the different systems under consideration. This study indicates that a two-stage blower system with barometric condensers is the most economical arrangement. The cascade type (high head loss) decarbonation pond considered in this study is uneconomical; however, a low head loss pond might be useful if it worked effectively. The evaluation of a large number of alternative materials led to the conclusion that the ejector and the blower systems must be constructed of premium materials such as stainless steel, titanium, or Hastelloy C because of the highly corrosive environment. An addendum is presented which reviews designs of noncondensable removal systems in the fifteen OSW 50-Mgd conceptual plant designs. These reviews indicate that the general design philosophy of removing noncondensables has not been standardized. The areas of disagreement include type and size of equipment, materials of construction, amount of air inleakage, steam requirements for ejectors, and the number of ejector stages required in series. (auth)

43091 (ORNL-TM-1966) VARIATION OF SHOCK OVERPRESSURE WITH DISTANCE IN AN EXPLOSIVELY DRIVEN SHOCK TUBE. Dresner, Lawrence (Oak Ridge National Lab., Tenn.). Sept. 12, 1967. Contract W-7405-eng-26. 49p. Dep. CFSTI.

Variations of shock overpressure with distance down a shock tube were calculated for the following two methods of driving a shock tube: rapid smokeless powder burning in a closed driver section confined with a breakable membrane, and detonation of an explosive gas mixture confined by a breakable membrane. Results were compared with results found by detonating a small amount of high explosive at one end of a tube far down the tube, variations of shock overpressure of the three methods were indistinguishable if the total energy is the same in all methods. Near the end of the driver tube, shock produced by rapid burning smokeless powder and detonation of a gas explosive is unusual. This behavior was analyzed and shown to be due to propagation of rarefaction waves through the gas behind the shock front. Numerical calculations explaining the flow process are discussed. (F.S.)

43092 (UCRL-17436) PROGRAM FOR INVERSION OF SYSTEM ANALYSIS AND ITS APPLICATION TO THE DESIGN OF MAGNETS. Halbach, Klaus (California Univ., Berkeley. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 32p. (CONF-670705-14). Dep. CFSTI.

From 2nd International Conference on Magnet Technology, Oxford, England.

In recent years many computer programs have been developed that can be used to analyze the performance of specified systems. The design of a system can be interpreted as the task of finding a set of parameters that leads to a desired performance of that system. PISA is a general purpose Program for Inversion of System Analysis that does this automatically in the following sense: Combined with the appropriate analysis program and given a starting configuration of a system, it varies a given set of parameters until a specified performance is obtained within close tolerances. For example, given the desired field configuration in the aperture of a strong-focusing magnet of given basic design such as an H magnet, the geometry of the pole face may be determined. PISA has been coupled to several analysis programs and application of these packages to the design of magnets is discussed. It is also shown how this method can be used to find the adjustments of parameters that are necessary to obtain a desired performance of an existing piece of equipment. (auth)

43093 (UCRL-70412) EVALUATION OF THE RISETIME OF SOME INTRINSICALLY SPOTWELDED THERMOCOUPLES. Field, John E. (California Univ., Livermore. Lawrence Radiation Lab.). June 26, 1967. Contract W-7405-eng-48. 27p. (CONF-671001-2). Dep. CFSTI.

From Society of Experimental Stress Analysis, Chicago, Ill.

The technique limitations and material-selection problems of utilizing spotwelded thermocouples are described. To determine these limitations, thermocouples were spotwelded to a metal strip and a capacitor bank was discharged through the strip to obtain a step rise in temperature. The results of these tests have revealed some unsuspected problems and technique limitations such as magnetostriction. Several suggestions are given for selecting materials and optimizing welds. These suggestions have proven effective in narrowing the band of uncertainty in predicting the ability of a thermocouple to respond to surface temperatures. (L.C.L.

43094 (UCRL-70494) TRANSFER SYSTEMS FOR THE LIVERMORE NEUTRON CELLS. Hanson, C. L.; Coops, M. S.; Parkison, C. D. (California Univ., Livermore. Lawrence Radiation Lab.). July 10, 1967. Contract W-7405-eng-48. 18p. (CONF-671102-19). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Special transfer systems are required to handle fission sources in the neutron cells being built at Livermore. These systems are remotely operated behind four foot thick neutron shielding. Several transfer systems are directly connected to the cell liners which contain the intense alpha activity. Components are built in modules to permit easy replacement. Several devices were designed to permit remote replacement of plastic booting to assure continued operations in the cells. (auth)

43095 (WAPD-TM-663) DETERMINATION OF LOADS TO CREATE A FULLY PLASTIC PIPE CROSS SECTION. Snow, A. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). June 1967. Contract NObs 90029. 43p. Dep. CFSTI.

One of the failure modes of piping systems is gross yielding. If pipe loadings are restricted to values which exclude fully plastic cross sections, gross yielding of the pipe will not occur. Limit load theory provides a set of rules which, if satisfied, ensures that the resulting loads are at or below the values which initiate gross yielding. A procedure has previously been developed which estimates the limit loads (neglecting the shear load) of an elastic-perfectly plastic pipe which obeys the Tresca Yield criterion. The extension of that analysis to include shear effects and to give limit loads for both Tresca and Von Mises criteria are given. (auth)

43096 (Y-1578) AIR-BEARING SPINDLE FOR PRODUCTION MACHINE TOOLS. Steger, P. J.; Abbatiello, L. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 25, 1967. Contract W-7405-eng-26. 45p. Dep. CFSTI.

A production-sized, externally pressurized and air-lubricated spindle, capable of supporting 400-pound cantilevered loads, was fabricated for use in a program designed to improve the accuracy of a Heald 15 by 15-inch numerically controlled turning and boring machine tool. Heat generation in the precision ball bearings of the original spindle gave indications of being a significant source of inaccuracy in parts machined on the lathe. Because of the low friction and subsequent low heat-generation characteristics of the air bearing, the spindle was successfully used to reduce the associated errors, while providing improved rotational accuracy. (auth)

43097 (Y-1581) AIR-BEARING SPINDLE FOR MACHINE TOOLS: SPHERICAL DESIGN. Steger, P. J. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 29, 1967. Contract W-7405-eng-26. 37p. Dep. CFSTI.

Externally pressurized air-lubricated spindles using porous graphite compensation have been improved using hemispherical, self-aligning bearings. Consequently, the spindles are simpler and easier to fabricate and assemble when compared to the air spindle, previously fabricated, which used the cylindrical journal and flat thrust design. This improvement has increased the suitability and economical feasibility of the air-bearing spindle for routine shop use, while maintaining load capability, dynamic stability, thermal stability, and rotational accuracy. Three spherically designed air-bearing spindles have been fabricated at the Oak Ridge Y-12 Plant, have successfully passed the test stage, and are presently in use on numerically controlled turning and boring machine tools. (auth)

43098 (AEC-tr-6893) THERMAL DISTILLATION OF SEA WATER. (FUNDAMENTALS OF THE THEORY OF MARINE EVAPORATORS). Kovalenko, V. F. Translation of Termicheskoe Opresnenie Morskoi Vody, Elementy Teorii Morskikh Isparitelei, Transport Publishing House, Moscow, 1966. 230p. Dep. CFSTI.

Fundamentals of thermal distillation, molecular physics of water, structure and properties of sea water, and modifications of thermal distillation equipment are described. Types of shipboard evaporators, sources of heat, including isotopic heat sources and reactors, and the use of waste heat are reviewed. Fundamental theory, heat transfer, automation, design, efficiency, and scale formation are discussed for thermal distillation. A bibliography of 155 references is included. (F.S.)

43099 RADIATION PROTECTION CALCULATIONS: A SYSTEMATIC APPROACH. Alvi, Z. M.; Wolever, T. H. S. (Kaiser Foundation Hosp., Los Angeles). Indian J. Radiol., 19: 139-49 (1965).

A method for arriving at the required wall thicknesses for a planned radiation therapy department incorporating one rotational ^{60}Co, one stationary ^{60}Co, and one orthovoltage 300 kVp x-ray machine, is described. For 3000 Ci ^{60}Co rooms, considering a max workload of 50,000 R/wk at 1 m, the required concrete wall thickness is 21 in. for 300 kVp x-ray room considering a workload of 20,400 ma min/wk, the required thickness for lead-sheet barrier is $^{3}/_{16}$ in. For the roof, 1 ft of concrete is sufficient. The lead-glass window thickness for cobalt rooms, and x-ray room should be 8 and 1 in., respectively. (Indian Sci. Abstr.)

43100 METHOD AND MEANS FOR CONSTRUCTING PRESSURE VESSELS. Adler, Felix Max British Patent 1,084,432. Sept. 20, 1967. Filed July 24, 1964.

A method is described for the construction of prestressed cylindrical shells adapted for use in pressure vessels. A stack of at least two annular members is wound with cables around their periphery. The segments of the members are forced apart by jacks to put the cables in tension. The segments are secured by the cables. The jacks are located in the gap between the segments of the shell and the gaps are filled with reinforced concrete when the jacks are removed. A gas-proof lining such as polyvinyl chloride is used on the internal wall of the vessel and the vessel is subjected to test pressure while an external skin of reinforced concrete is formed. The test pressure is released when the skin is completed causing the vessel to contract putting the external skin into compression or prestress. (F.S.)

43101 DEVICE FOR PRODUCTION OF A HOLLOW SPHERE. (to NUKEM Nuklear-Chemie und-Metallurgie, GmbH). British Patent 1,083,993. Sept. 20, 1967. Priority date Sept. 13, 1963, Germany.

A device for the production of hollow spheres used for reactor fuels is described. A spherically hollow sphere produced from a solid sphere has an inlet of uniform cross section, the diameter of which is smaller than the diameter of the cavity. A cutter with a pointed tip is inserted into the inlet and is pivoted about a point near the inlet and moved so that the cutting surface of the cutter describes the arc of a circle. The radius of the arc corresponds to the desired radius of the cavity. (F.S.)

43102 ACQUA DOLCE DAL MARE. ATTI DEL SIMPOSIO INTERNATIONALE TENUTOSI A MILANO, APRIL 18-19, 1966. (Fresh Water from the Sea. Reports of the International Symposium, Milan, Apr. 18-19, 1966). Milan, Federazione delle Associazioni Scientifiche e Techniche, 1966. 191p. (CONF-660458).

Eleven papers presented at the 1966 International Symposium on Fresh Water from the Sea, held in Milan, Italy, April 18 to 19, 1966 are presented. Developments in research on and production of desalinated water in France, Greece, Israel, Mauritania, Soviet Union, United Kingdom, and United States are described. A short history of water desalination from antiquity to the 19th Century is presented as an appendix. (L.C.L.)

43103 ELECTROLYSIS-RESISTANT ELECTRON DISCHARGE DEVICE. (to Radio Corp., of America). British Patent 1,083,740. Sept. 20, 1967. Priority date Jan. 22, 1964, United States.

An electron discharge device is described in which the rate of electrolysis is retarded to such extent that relatively low resistance and inexpensive glass members are employed. The device consists of an evacuated glass envelope, an electron assembly within the envelope, a time glass member which is a bulb forming part of the envelope, and a ^{63}Ni beta source mounted within the envelope but outside the electron assembly. The glass member is exposed to beta radiations so as to retard the rate at which electrolysis occurs during operation of the device. The device is suitable for use as a horizontal deflection amplifier in television receiver circuits. Anode voltages of the order of 10,000 V are encountered. (F.S.)

43104 DEVICE FOR LOADING AND UNLOADING FLASKS OF THE TYPE EMPLOYED FOR TRANSPORTING IRRADIATED MATERIALS. Vertut, Jean; Fradin, Jean; Raggenbass, Andre (to Commissariat a l'Energie Atomique). British Patent 1,083,796. Sept. 20, 1967. Priority date Apr. 20, 1965, France.

A device used in loading and unloading flasks at hot cells is described. The flasks are used in transporting irradiated materials. The flasks are placed on a rocking support which moves the flask from a vertical to horizontal or horizontal to vertical position. The support has an epicyclic motion produced by the rolling motion of a toothed sector. The support runs on a horizontal rack carried by a stationary, height-adjustable table. A device for removing the flask plug and a means for forming a leak tight seal are provided. (F.S.)

43105 CERAMIC COMPONENTS USED IN PLUTONIUM ELECTROREFINING (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-1633).

4 drawings

Ceramic accessories used in electrorefining of plutonium are described. The accessories include an electrorefining cell, stir-

ring rod, and an anode sheath. The cell is 4¾ in. in dia, 20 in. high and the anode chamber within the cell is 2⅜ in. in dia and 3½ in. high, cast of MgO–2 wt % Y_2O_3. The stirrers are a solid cast of MgO–3 wt % Y_2O_3 and are 8$^{3}/_{32}$ in. long and are $^{5}/_{16}$ in. in dia. The anode sheaths are drain cast magnesium oxide. They are 6¼ in. long 0.370 in. OD and 0.360 in. ID. The accessories have high thermodynamic stability, adequate thermal shock resistance, and are mechanically strong. (For details see TID-4100 Suppl. 42.) (F.S.)

43106 PNEUMATIC HAMMER (Engineering Materials). (Sandia Corp., Albuquerque, N. Mex.). (CAPE–1638).

12 drawings.

A pneumatic hammer is described which was developed for low stress level (1 to 20 kilobars) impact studies. The hammer is used in testing and calibrating piezoresistive pressure transducers. The projectile face and impact surface are designed so that a planar impact is obtained with an accompanying fast stress-wave rise time. The projectile velocity is measured just before impact by a parallel light-beam photo-diode detector system. The equipment is free from electric noise and more than adequate safety measures are employed. (For details see TID-4100 Suppl. 42.) (F.S.)

43107 POWERED AIR-PURIFYING RESPIRATOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1645).

16 drawings.

A personal powered air-purification respirator is described which provides a protection factor of 1000 against particulates when used with half masks, full-face masks, rigid helmets, and hoods. The apparatus consists of a motor-fan, power supply, air purifying element, and an air delivery hose. (For details see TID-4100 Suppl. 42.) (F.S.)

43108 COOLING TUBES (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1648).

2 drawings.

Cooling tubes are described which carry water to maintain a constant temperature in sections of the Stanford Linear Accelerator in order that the internal dimensions of the section will remain unchanged. (For details see TID-4100 Suppl. 43.) (F.S.)

43109 SLAC PHASING SYSTEM (Engineering Materials). (Stanford Linear Accelerator Center, Calif.). (CAPE–1584).

96 drawings.

The phasing system for the Stanford Linear Accelerator is described. This system enables klystron power to be introduced into the accelerator at the proper time, so that the klystron power will be in synchronism with the power induced by the beam inside the same accelerator section. (For details see TID-4100 Suppl. 43.) (F.S.)

43110 MERCURY JET SWITCH (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1647).

19 drawings.

A mercury jet switch is described which is used to meet high-current, long duration series switching requirements of the electrolytic capacitor banks used with the Levitron. The switch which was to relieve a major share of the discharge load on the ignitrons following their initial switching and be capable of operating twice a minute showed in tests that it can replace the series switching ignitrons. The switch is air operated with mercury being stored in stainless steel bellows. Air pressure is abruptly applied to the outside of the bellows causing mercury ejection from the bottom electrode through a cone orifice toward the top of the electrode. The electrodes are enclosed in evacuated Pyrex glass. Initial load tests on the switch made with a capacitor bank-coil combination capable of giving an 8000-A peak current with a ¼-cycle, showed a rise time of 11 msec and a 25 msec L/R decay. The switch operated up to the available peak of 8000 A repeatedly and gives every indication of being able to exceed this figure as inferred by the nominal 8-V drop across the switch at 8000 A. Closing time of the switch for the tests was 20 ± 0.2 msec. (For details see TID-4100 Suppl. 43.) (F.S.)

43111 ADJUSTABLE VOLUME VALVE (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1637).

4 drawings.

An automatic, variable volume valve or gas dispenser is described for use in calibration of vacuum analytical systems by injecting into the system small known volumes of a standard gas ranging from ~0.030 to 3 cc STP. The device consists of: a brass body, two opposing air operated valves (for inlet and outlet control), and a cylindrical buret whose internal volume can be varied. The valves produce a minimum internal volume when closed. The ½ in. dia piston can be moved 1 in. and its position determined to 0.0001 in. There is a small amount of leakage when the piston is adjusted to a new volume but this leakage does not hinder the usefulness of the device. (For details see TID-4100 Suppl. 43.) (F.S.)

43112 METHOD OF TESTING RAINFALL TO DETERMINE ITS RADIOACTIVITY OF RAINFALL AND APPARATUS FOR PERFORMING THE METHOD. Goupil, Jean (to Commissariat a l'Energie Atomique). British Patent 1,085,183. Sept. 27, 1967. Priority date Sept. 1, 1964, France.

An apparatus is described which measures the beta and gamma radioactivities in rain falling at rates up to 40 liters per hour per m^2. (L.C.L.)

43113 FLANGE JOINT. (to Rederiaktiebolaget Nordstjernan). British Patent 1,085,027. Sept. 27, 1967. Priority date Dec. 6, 1963, Sweden.

The design of a flange joint for connecting two parts of a pressure vessel is described. These have particular application to vary large (10 to 30 ft dia) vessels with high internal pressure, such as are used with nuclear reactors. (L.C.L.)

43114 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Heathcote, John (to Foster Wheeler Ltd.). British Patent 1,085,361. Sept. 27, 1967. Filed Mar. 29, 1963.

A linkage mounting mechanism for heat exchanger tubing bundles is described. This linkage compensates for the thermal expansion of the heat exchanger casing by maintaining a fixed position of the tubing where it is attached to a rigidly fixed heat exchange fluid header. Maintaining the position of the tubing bundles relative to the headers avoids excessive stress on the headers. This device has particular application to heat exchangers used in nuclear power plants. (L.C.L.)

43115 OPTICAL EXTENSOMETER /Q-2880/ (Engineering Materials). (Oak Ridge National Lab., Tenn.). (CAPE–1646).

5 drawings

An automatic recording precision optical spectrometer was fabricated and modified for making strain measurements on test specimens at elevated temperatures where direct contact with the specimen is not possible. A null-balance servo system coupled to an x-y plotter produces stress strain diagrams. Wiring diagrams are given for drives and controls of the telescopes and apertures. (For details see TID-4100 Suppl. 42). (F.S.)

43116 IMPROVEMENTS IN AND RELATING TO IRRADIATION. (to Sulzer Brothers Ltd.). British Patent 1,084,891. Sept. 27, 1967. Priority date Apr. 14, 1964, Switzerland.

A conveyer system for moving unirradiated material past a radiation source is described. A horizontal feed system roller conveyer moves unirradiated material into the irradiation section. A double closed loop vertical chain conveyer picks up the individual loads of material and moves them past the radiation source. The irradiated material is deposited on a horizontal exit conveyer and discharged from the facility. (L.C.L.)

43117 AIR SAMPLING METHOD AND APPARATUS. Sanders, Merwyn (to U. S. Atomic Energy Commission). U. S. Patent 3,348,044. Oct. 17, 1967.

A method and apparatus for correlating the collection of samples taken at different times and places on separate filter papers with the display of data from analysis of such samples are described. Filter papers for collecting the samples are placed in apertures provided in precoded data processing cards which are then placed in special holders permitting passage of gaseous atmosphere through the filter paper while holding it taut. The cards are removed from the holders, the analyses performed, the results automatically punched onto the cards, the cards duplicated in uncontaminated form, and the duplicate cards tabulated to provide a data display. (AEC)

43118 DEVICE FOR CONSOLIDATING METAL POWDERS. Sandstrom, Donald J.; Terrell, Charles L. (to U. S. Atomic Energy Commission). U. S. Patent 3,346,914. Oct. 17, 1967.

A molding device for compacting metal powders into tubular or rod shapes is described. The device has an inner electrical conductor which is shaped to provide a molding cavity having the general shape of the article desired to be produced, and an outer electrical conductor which completely surrounds the inner conductor, is insulated from it, and is clad with a nonmagnetic metallic sleeve. Both conductors are connected to a power supply and switching mechanism. (AEC)

43119 DEVICE FOR ATTACHING A THERMOCOUPLE PROBE TO A METALLIC WALL. Le Polles, Robert; Schley, Robert (to Commissariat a l'Energie Atomique). British Patent 1,084,989. Sept. 27, 1967. Priority date Apr. 30, 1965, France.

A device is described which is used to attach a thermocouple to

a metallic wall such as the can of a nuclear fuel element, the surface temperature of which is to be measured when the fuel element is in an operating reactor. The device consists of a metallic terminal connector with an axial blind-end bore used to position the thermocouple probe. A series of holes terminate at right angles in the bore and a second series of holes traverse the terminal connector. Both series of holes permit the introduction of brazing compound for forming bonds between the probe and terminal connector and the metallic wall. The device has high mechanical strength, is resistant to pressures caused by coolant flow, and has high temperature resistance even in the event of violent thermal shock. (F.S.)

43120 PIPETTE HOLDER. Douis, Michel; Falconi, Robert (to Commissariat a l'Energie Atomique). British Patent 1,085,890. Oct. 4, 1967. Priority date Nov. 16, 1964, France.

A movable pipet holder is described which is used to simplify and accelerate the removal and distribution of radioisotopes. The pipet holder consists of a casing, a sliding member which passes vertically through the base of the casing and is secured outside the casing to a rack which holds one or more pipets, a motor which drives the sliding member, and stops which limit the displacements of the sliding member by stopping and starting the motor. Pipets stored on the rack may have identical or different capacities. Several amounts of the same or different liquids may be removed and poured out at the same time accelerating distribution. (F.S.)

43121 DEVICES FOR MONITORING THE PHYSICAL CHARACTERISTICS OF TUBULAR ELEMENTS. Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,085,677. Oct. 4, 1967. Priority date June 24, 1965, France.

A device is described for monitoring the physical characteristics of parallel tubular elements located in a regular lattice such as the pressure tubes in a reactor. The device is small, convenient for operation between the pressure tubes, may be inserted or withdrawn from the reactor, and consists of probes carried by a moving trolley fitted with movable rollers. The trolley has a self-contained mechanism to drive the rollers so as to produce translational motion along two adjacent tubular elements. Rails located at right angles to the tubular elements are used to transfer the trolley from one position to another between any two adjacent tubular elements. (F.S.)

43122 INDUCTION PUMP FOR CONDUCTIVE LIQUIDS. Mezhburd, Volf Iolevich; Parts, Romeo Rudolfovich; Teearu, Viktors Andreevich (to Nauchno-Issledovatelsky Elektrotekhnichesky Instituut). British Patent 1,085,471. Oct. 4, 1967. Filed Mar. 28, 1966.

An asynchronous induction pump used in pumping molten metals in foundries, nonferrous metallurgy, atomic power engineering, and the chemical industry is described. The device pumps electrically conductive liquids by applying a magnetic field to the liquids. The field is set up by an induction device arranged adjacent to a part of a channel carrying the liquid. The inductor device consists of two co-axial ferromagnetic cores. A magnetic core element is used for decreasing the air gap and resistance to the magnetic flux in the portion of the magnetic circuit of the inductor device which is inoperative. (F.S.)

43123 METHOD AND APPARATUS FOR UNDERWATER RADIOLOGICAL INSPECTION, ESPECIALLY IN THE WATER-TANK OF A SWIMMING POOL REACTOR. Briffaud, Georges (to Commissariat a l'Energie Atomique). British Patent 1,085,961. Oct. 4, 1967. Priority date May 6, 1965, France.

A method for radiological inspection of an object within an immersed tubular container such as an irradiation loop located in the tank of a swimming pool reactor is described. A liquid-tight casing closely surrounding the tubular container is remotely moved slowly along the container. A liquid-tight radiological transmitter is put in the casing so that radiation produced by the transmitter passes through the object in the container to a receiver which is inside the casing diametrically across from the transmitter. Radiation displaces the liquid-tight casing in relation to the container. The displacement is detected by television cameras or radiography. (F.S.)

43124 IMPROVEMENTS RELATING TO PRESSURIZED VAPOR GENERATORS. O'Neil, Robert (to United Kingdom Atomic Energy Authority). British Patent 1,086,243. Oct. 4, 1967. Filed Jan. 26, 1965.

A steam generator for a boiling water power reactor arranged for direct cycle operation is described. The liquid to be vaporized undergoes forced recirculation in a circuit containing a heater. The heater is located in a vessel which also holds the recirculation circuit, jet pumps, and a number of penetrations each of which is equipped with an external feed pump and nonreturn valves. (F.S.)

43125 IMPROVEMENTS RELATING TO RELEASABLE COUPLINGS. Thomas, Glyn Eloy (to Fairey Engineering Ltd.). British Patent 1,086,058. Oct. 4, 1967. Filed Aug. 2, 1963.

Releasable couplings used to connect two adjacent runs of longitudinally movable cables to enable one of the cable runs to be driven by the other are described. The couplings may be used in reactors to oscillate samples in a void in the core while the reactor is under controlled heat and nuclear flux conditions. (F.S.)

43126 POSITION SENSING SYSTEM. Akesson, Jan Assar (to Aktiebolaget Atomenergi). British Patent 1,084,552. Sept. 27, 1967. Priority date Oct. 22, 1963, Sweden.

A sensing system operating by ultrasonics is described for use in indicating the position of control rods in a nuclear reactor. There are no components of the system which can be harmed by thermal or nuclear radiation. (F.S.)

43127 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Heathcote, John; Taylor, Eldred Alan (to Foster Wheeler Ltd.). British Patent 1,084,804. Sept. 27, 1967. Filed Mar. 29, 1963.

A heat exchanger is described which consists of a bundle of tubes connected at their ends to heat exchange fluid inlet and outlet headers which pass through the wall of a shell or casing whose length, where the bundle is located, extends vertically. One use for the heat exchanger is in a nuclear power plant. The heat exchanger is located within the reactor vessel and the inlet and outlet headers pass through and are embedded in the concrete radiation shield. The tube bundle is supported by being suspended from a grid-iron arrangement from the upper end of the casing. (F.S.)

43128 METHOD AND APPARATUS FOR MEASURING THE MEAN PORE RADIUS OF A POROUS BARRIER. Bonnet, Jean (to Commissariat a l'Energie Atomique). British Patent 1,086,297. Oct. 4, 1967. Priority date Sept. 28, 1964, France.

A method and an equipment are described for rapidly measuring the mean radius of pores of microporous membranes such as barriers employed in separating chemically identical hexafluorides from different uranium isotopes. The characteristics of a large number of barriers can be rapidly determined. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 43087, 43098, 43114, 43197, and 43876.

43129 (EUR-3356e) CRITICAL STUDIES ON STEADY BURNOUT. FINAL REPORT. PART I. CORRELATION FOR NONUNIFORM HEATING. PART II. STUDIES ON LINEAR CORRELATIONS. Clerici, G. C.; Garriba, S.; Sala, R.; Tozzi, A. (Applicazioni e Ricerche Scientifiche, Milan (Italy)). May 2, 1967. Contract 073-65-11 TEEI. 140p. (EURAEC-1833). Dep. CFSTI.

The most important burnout correlations are listed for uneven axial power distribution on simple geometry channels, both in their original form and in a reduced standard form, such as $\phi_0 = \phi_0 (X_0)$. ϕ_0 is the burnout critical heat flux and X_0 the outlet burnout steam quality. The burnout correlations for even axial power distributions were determined. The most important correlations can be reduced to the linear form $\phi_0 = a(b - X_0)$ by means of suitable transformations and approximations. A first linearized correlation is compared to the 1630 data points, on which the Becker correlation is based. In order to eliminate certain systematic errors two new linear correlations were established and tested against 2001 data points from various laboratories. The root mean square error over the 2001 data points is $\sigma = 7.4\%$. The data range is: $25 < P < 100$ ata, $20 < G < 500$ gr/cm^{2}s, $0.39 < D < 3$ cm, $20 < L < 500$ cm, $X_{in} < 0$, $X_0 > 70$. (auth)

43130 (FFA-110) HEAT TRANSFER MEASUREMENTS AT M = 7.17: FIRST STEP OF A COMPARISON BETWEEN TUNNEL TEST AND FREE FLIGHT. Thomann, H. (Flygtekniska Forsoksanstalten, Stockholm (Sweden)). Feb. 1967. 14p. Dep.

A paraboloid free flight model was designed, built and instrumented at the Royal Aircraft Establishment (RAE) in Farnborough. Prior to the flight, this model was tested in the hypersonic tunnel Hyp 500 at the Aeronautical Research Institute of Sweden (FFA). The model was designed to have uniform wall temperature during the test. As the same model is used in both tests and as the Mach number, the Reynolds number and the ratio wall temperature to free stream temperature are very nearly the same in both cases, the tunnel tests are an almost perfect simulation of the flight test. In the present paper, the

tunnel test (heat transfer and pressure distribution) are presented and compared with theory. Excellent reproducibility and good agreement with theory were found. The flight tests are planned to take place during the summer of 1967. (auth)

43131 (LA-DC-8716) STUDIES OF FORCED CONVECTION HEAT TRANSFER TO CRYOGENIC FLUIDS. Williamson, K. D. Jr.; Bartlit, J. R.; Thurston, R. S. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 30p. (CONF-671103-3). Dep. CFSTI.

From 60th Annual Meeting of the American Institute of Chemical Engineers, New York.

Recent forced convection heat transfer studies for $1H_2$ and $1N_2$ have been directed at steady and oscillating flow, correlation of data from many authors, and instrumentation problems. Data were obtained in pipes ranging in size from ¼-in. to 4.5-in. ID. (auth)

43132 (ORNL-TM-1912) A STUDY OF DETACHED TURBULENCE PROMOTERS FOR INCREASING MASS TRANSFER RATES IN AQUEOUS CHANNEL FLOW. Watson, Jack Samuel (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 255p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

The effectiveness of detached cylindrical turbulence promoters in improving mass transfer rates in aqueous channel flow was studied. A rectangular channel (0.49 by 2.5 in. in cross section) was employed at Reynolds numbers from 513 to 5800 (based upon the smaller channel axis). Promoters of three different diameter sizes (1/16 in., 3/32 in., and ⅛ in.) were tested with three different spacings of the promoter center line from the wall (1/16 in., 3/32 in., and ⅛ in.). The rate of ferricyanide reduction at a polarized electrode (or test surface) with a large excess of supporting electrolyte (sodium hydroxide) was measured. The promoters locally increased the mass transfer rate to as much as eight times the unpromoted rate; the average transfer rate over the entire test surface was increased as much as threefold. For a given increase in mass transfer rates, turbulence promoters required smaller increases in pumping power than would have been required by increased circulating rates in clear, or unpromoted, channels. The maximum promotion occurred at a Reynolds number near the laminar-turbulent transition point. The optimum promoter spacing from the wall appeared to be approximately 1.5 diameters, and the optimum spacing between promoters appeared to be approximately 8.0 diameters. Measurements were made of the fluctuating, as well as the mean (time-averaged) component of the mass transfer rate. Also, using very small, isolated electrodes, measurements could be made which were related to the mean and fluctuating velocities very near the wall. A mathematical analysis was developed to describe the effects that velocity disturbances near the wall will have on the mean and fluctuating component of the mass transfer rate. Although the analysis could not be completely evaluated because of the unavailability of sufficient satisfactory data on disturbance frequencies and propagation velocities, some comparisons of the analysis with experimental data were possible and agreement in these cases was satisfactory. (auth)

43133 (SCL-DR-67-30) HEATMESH: A COMPUTER CODE FOR GENERATING GEOMETRICAL DATA REQUIRED FOR STUDIES OF HEAT TRANSFER IN AXISYMMETRIC STRUCTURES. Gabrielson, V. K. (Sandia Corp., Livermore, Calif.). Sept. 1967. Contract AT(29-1)-789. 62p. Dep. CFSTI.

HEATMESH defines nodal networks for heat-transfer problems in complex structures represented as surfaces of revolution. The program has two phases. In the first, the structure to be studied is divided into parts with common material properties. These parts, whose boundaries constitute the input to the code, are subdivided into nodes whose geometrical properties are tabulated and stored. In the second, data for adjacent nodes are calculated, tabulated, and stored. The data generated are designed for the difference equations used in Sandia's heat-transfer programs, such as HEATFLOW. (auth)

43134 (TID-24043) THE MEASUREMENT, INTERPRETATION, AND USES OF UNSTEADY MOMENTUM FLUXES IN TWO-PHASE FLOW. Report No. 70318-50. Tien Sieh Yih; Griffith, Peter (Massachusetts Inst. of Tech., Cambridge. Dept. of Mechanical Engineering). Aug. 1967. Contract AT(30-1)-3496. 35p. Dep. CFSTI.

The steady and unsteady components of the momentum flux in a two-phase flow have been measured at the exit of a vertical pipe by means of an impulse technique using a turning tee and beam. Different electrical filters have been tried in the recording circuit for eliminating the signals around the natural frequency of the beam system. A special filter set has been designed to approximate the inverse of the transfer function of the beam system. Thus the signals recorded after passing through the beam-filter combination can be considered as the excitation times a constant. Two different analog methods have been used to analyze the random signals for obtaining some statistical quantities such as the predominant frequency and the rms value of the unsteady momentum flux. These quantities are useful in some applications involving two-phase flow. In the preliminary measurements of the unsteady momentum flux for the adiabatic up flow of an air-water mixture in a ⅝ inch pipe, the greatest unsteadiness of momentum flux appeared in the quality range of one per cent to six per cent. Above ten per cent quality no appreciable fluctuation has been detected. In an example problem, using the preliminary results, the effect of the unsteady momentum flux on a fuel rod has been studied. The amplitude of the vibrations resulting from the two-phase excitation has been found. In addition it has also been found that there is a possibility of unstable vibrations due to a nonlinear restoring force on the fuel element. This nonlinearity is due to the unsteady component of the momentum flux in the flow past the rod. (auth)

43135 RELATIONSHIPS BETWEEN BUBBLE FREQUENCY, DEPARTURE DIAMETER, AND RISE VELOCITY IN NUCLEATE BOILING. Ivey, H. J. (Science Research Council, London). Int. J. Heat Mass Transfer, 10: 1023-40(Aug. 1967).

Many analyses of boiling heat transfer include the terms bubble frequency f, bubble diameter D, and bubble rise velocity u, in their expressions for nucleate boiling heat flux and critical heat flux. In order to simplify these expressions, individual relationships between f and D, and the relationship $u = fD$, are often used over the entire range of bubble diameters. Evidence is presented which indicates that a single relationship only approximately correlates f with D for all nucleate boiling bubble diameters. Three separate regions are suggested by the experimental data, which correlate the data for each region better than a single relationship: (a) hydrodynamic region, in which the major forces acting on the bubble are buoyancy and drag: $fD^{½} = 0.90\ g^{½}$; (b) transition region, in which buoyancy, drag and surface tension forces are comparable: $fD^{½} = 0.44\ g^{½}\ (cm^{½})$; and (c) thermodynamic region, in which conditions during bubble growth predominate; fD^2 = constant. Theoretical explanations for the variation of f with D are proposed for regions (a) and (c). Experimental observations indicate that the relationship $u = fD$ is only approximately valid over the range of bubble diameters: $0.02 > D > 3$ cm. The relationship $u/fD = 1$, therefore, should not be incorporated into accurate theoretical analyses of the boiling phenomenon, in which the proportionality constant relating dimensionless groups is obtained as an exact theoretical value. (auth) (UK)

43136 INTENSIFICATION OF HEAT TRANSFER IN CHANNELS. Bogdanov, F. F.; Korshakov, A. I.; Utkin, O. I. At. Energ. (USSR), 22: 428-31(June 1967). (In Russian).

Investigations of the effects of artificial roughness in the heat extracting surfaces of heat exchange device on heat transfer and hydraulic resistance were described. Empirical relations for the calculation of the heat extraction and the hydraulic resistance in heat exchange using such surfaces were derived. (tr-auth)

43137 HEAT CONDUCTION OF A LAMINAR LAYER OF LIQUID METAL. Ivanovskii, M. N.; Orlov, Yu. I.; Subbotin, V. I. At. Energ. (USSR), 22: 231-3(Mar. 1967). (In Russian).

The wall temperatures in a 90 mm tube containing a turbulent flow of lithium metal were measured at the wall and at distances of 3.75 and 6.25 mm from the wall by three microthermocouples. The experiments were carried out in the presence of pure metal and in the presence of insoluble nitrides suspended in the lithium metals. The Peclet number (Pe) was varied from 200 to 800. The change in temperature distribution near the wall with the contaminated liquid lithium metal showed that the insoluble impurities accumulated on the wall and substantially decreased the thermal conductivity of the wall layer. The thermal conductivity of the nitride mixture was 6 to 8 kcal $m^{-1}\ hr^{-1}\ °C^{-1}$ at 300°C compared with a value of 40 kcal $m^{-1}\ hr^{-1}\ °C^{-1}$ for pure lithium metal at 300°C. The average heat transfer coefficient for pure lithium metal corresponded to the values calculated from the following formula: $Nu = 5 + 0.025\ (Pe)^{0.8}$. Contamination of the lithium metal by suspended impurities led to a decrease in the heat transfer coefficient to values given by the following formula: $Nu = 3 + 0.014\ (Pe)^{0.8}$. The decrease in heat transfer reaches a limiting value. (TTT)

43138 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7-12, 1966. VOLUME I. New York, American Institute of Chemical Engineers, 1966. 427p. (CONF-660801-(Vol.1)).

A total of 40 papers presented at the conference is included in volume one. Separate abstracts were prepared for fourteen papers. Papers for which no abstracts were prepared are concerned with single-phase forced convection heat transfer, and heat exchanger performance. (J.R.D.)

For abstracts of individual papers see: 43139-43152.

43139 FORCED CONVECTION HEAT TRANSFER FROM SURFACES ROUGHENED BY TRANSVERSE RIBS. Wilkie, D. (United Kingdom Atomic Energy Authority, Seascale, End.). pp 1-19 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Heat transfer and pressure drop data collected from annuli with heated roughened inner and unheated smooth outer surface, are presented for various inner surfaces roughened by transverse square and rectangular ribs, by applying the Hall transformation, whose validity has been tested in rectangular channels and by studying the smooth friction factor. Rib heights varied from 0.1 to 1.6% of the equivalent dia and pitch-to-height ratios from 2½ to 50. The effect on friction factor of surface to coolant temperature ratio and of rib profile, width and helix angle have been investigated as have static pressure and Stanton number between ribs. (auth)

43140 CALCULATION OF HEAT TRANSFER AND FLOW RESISTANCE OF ROUGH AND SMOOTH SURFACES CONTAINED IN A SINGLE PASSAGE. Wilkie, D. (United Kingdom Atomic Energy Authority, Seascale, Eng.). pp 20-31 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Measurements were made of the heat transfer and frictional properties of passages containing rough and smooth surfaces, although the properties of the roughened surface have been of primary interest. It is therefore necessary to be able to separate the properties of the component surfaces, particularly if the results are to be applied to passages of different configurations. Various methods have been proposed. Their principles are discussed and the assumptions they invoke are examined and tested against experimental measurements. The effects of errors in the assumptions are estimated and the overall accuracy of the methods is considered. (auth)

43141 THE CORRELATION OF FORCED CONVECTION HEAT TRANSFER DATA FROM ROUGH SURFACES IN DUCTS HAVING DIFFERENT SHAPES OF FLOW CROSS SECTION. Edwards, F. J. (Univ. of Manchester, Eng.). pp 32-44 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Methods of correlating data from large scale rough-surface heat transfer are examined. Effects of duct cross section and shape are emphasized. Data from three different roughnesses on a flat surface and on the inner tube of an annulus have been correlated with reasonable success. Other data from an annulus and a flat surface are shown to correlate, but more results are required for circular tubes. (auth)

43142 NEW TYPE OF ROUGHENED HEAT TRANSFER SURFACE SELECTED BY FLOW VISUALIZATION TECHNIQUES. Mantle, P. L. (Central Electricity Generating Board, Berkeley, Eng.). pp 45-55 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

The flow of air around various types of roughness placed on a smooth surface has been studied in a small wind tunnel using flow visualization methods. The shapes of roughness considered were a cube in parallel and diamond orientations, a cylinder, and a transverse square rib. From the flow patterns alone it was possible to suggest the design of a good heat transfer surface having spaced out individual roughnesses. This surface consisted of cubes in the diamond orientation, i.e., their diagonals parallel to the flow, and spaced at 6.5 times their height. The performance of this surface with 0.047-in.-high diamonds was measured accurately, and found to equal the performance of a highly developed ribbed surface. (auth)

43143 HEAT TRANSFER TO NONCIRCULAR THROAT BODIES. Talmor, Eliyahu (Rocketdyne, Canoga Park, Calif.). pp 77-84 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Noncircular-throat-body heat transfer results with and without water film cooling are presented. The throat body employed had a ⅜-inch dimension in cross flow and an axes ratio of 2.5. With film cooling, improved cooling effectiveness was encountered in comparison with ⅜-inch OD throat tubes. Without film cooling, the results indicate reduced heat fluxes in good agreement with the prediction of the turbulent boundary layer theory. Generalized correlation of circular and noncircular-throat-body heat transfer data is accomplished in terms of the attached flow length of the throat body involved. (auth)

43144 THE EFFECT OF A 180° BEND ON HEAT TRANSFER TO WATER IN A TUBE. Ede, A. J. (National Engineering Lab., Glasgow). pp 99-103 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

U bends in heat exchanger tubes may influence performance. The effect of a 180° bend on the local heat-transfer coefficient between a tube and water flowing through it was investigated. Three bends of radius ratios 4 : 1, 8 : 1, and 22 : 1 at Re = 700 to 42,000 were used. Curves of tube temperature or local heat-transfer coefficient against position along tube for turbulent, laminar and transitional flow are discussed. Particularly striking effects are obtained with laminar and transitional flow. A design chart is given, from which it should be possible to make reasonably reliable predictions of results for other bends and Reynolds numbers. (auth)

43145 THE EFFECT OF THE VENTING ARRANGEMENTS DURING THE CONDENSATION ON A HORIZONTAL TUBE FROM A STATIC VAPOUR–GAS MIXTURE. Hampson, H.; Thain, W. (Univ. of Aberdeen, Scotland). pp 118-29 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Four systems of supply and venting for experimental single tube condenser cells are described. The correlations for heat transfer coefficient and mass transfer coefficient, for open and closed cells, devised by previous experimenters, are discussed and compared with the presented results for an open cell with various venting arrangements. A new correlation is proposed, and proposals for a comparator cell for tubes with various forms of extended surface are included. (auth)

43146 MATHEMATICAL AND PRACTICAL ASPECTS OF HEAT TRANSFER IN DOUBLE PIPE HEAT EXCHANGERS. Stein, Ralph P. (Argonne National Lab., Ill.). pp 139-48 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

A mathematical analysis of heat transfer in double-pipe heat exchangers, based on first principles rather than on the use of heat transfer coefficients, is generalized to include laminar or turbulent flows, various geometrical configurations, and both co-current and counter-current operation. Practical aspects concentrate on accurate predictions of overall heat transfer rates, and include consideration of a quantity called the effectiveness coefficient for this purpose. Procedures for the interpretation of experimental data, derived from the analysis, are also suggested. (auth)

43147 THE INFLUENCE OF SURFACE HEAT FLUX DISTRIBUTION AND SURFACE TEMPERATURE DISTRIBUTION ON TURBULENT FORCED CONVECTIVE HEAT TRANSFER IN CLUSTERS OF TUBES IN WHICH THE FLOW OF COOLANT IS PARALLEL TO THE ACES OF THE TUBES. Redman, J. D.; McKee, G.; Rule, I. C. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 186-98 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Experimental work is reported on the influence of surface heat flux and surface temperature distribution on the fully developed heat transfer in triangular lattices of tubes of pitch-to-diameter ratios 1.0, 1.1, 1.25, and 1.5. The results are presented as functions which enable the response of the lattices to be calculated for a wide range of boundary conditions. The response to the uniform heat flux condition is shown to be related to the calculated wall shear stress distribution and to differ from that predicted by other workers. (auth)

43148 HEAT TRANSFER IN A DUCT IN REGIONS OF SEPARATED FLOW. Emerson, W. H. (National Engineering Lab., Glasgow). pp 267-75 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.1).

Measurements of heat transfer coefficients in pipes were made in regions of separated flow using circumferential grooves, ribs and sudden enlargements. Heat fluxes were kept low with Re = 20,000 to 250,000 and air as the working fluid. In all the tests a development length, usually heated uniformly, preceded the irregularity causing separation. Other tests were performed with small isolated heated areas downstream of a rib. Wall shear stress in the reattachment zone downstream of an enlargement was studied visually using oil drops. A peak in the heat-transfer coefficient occurs downstream of the irregularity and it is evident that this increase is determined by the length of separation and to a lesser extent by turbulence. (auth)

43149 HEAT TRANSFER EXPERIMENTAL RESEARCH FOR TURBULENT GAS FLOW IN PIPES AT HIGH TEMPERATURE DIFFERENCE BETWEEN WALL AND BULK FLUID TEMPERATURE. Petukhov, B. S.; Kirilov, V. V.; Maidanik, V. N. (Moscow Power Engineering Inst.). pp 285-92 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.1).

Research results of local heat transfer for turbulent gas flow in pipes at high temperature difference are presented. Measurements have been carried out with three tubes heated by an electrical current. Nitrogen was utilized as the heat transfer fluid. Experiments have been made over the range of Reynolds number of $13 \cdot 10^3 < Re < 300 \cdot 10^3$ and a temperature ratio of $1 < \theta < 6$. Experiments showed that the dependence of heat transfer on Reynolds number for different values of θ remains constant, however the influence of θ on heat transfer in its turn greatly depends upon x/d. Heat transfer is also influenced by the heat-flux density changes along the pipe and the method of evaluating this effect has been recommended. Experimental data are represented in dimensionless terms and a generalized equation has been proposed. Comparison of the data and theory with those of other workers has been made. (auth)

43150 HEAT TRANSFER IN LAMINAR SOURCE FLOW BETWEEN A STATIONARY AND ROTATING DISK. Kreith, Frank (Univ. of Colorado, Boulder); Viviand, H. pp 293-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.1).

An analysis of the Navier–Stokes equation for incompressible, laminar, non-dissipative flow between a rotating and a parallel stationary disk with a source in the center is presented showing how these equations can be solved for small clearances by means of a perturbation method. Three possible flow regimes are indicated and a method of solving the energy equation for two of these regimes is shown. The analytical solution for one flow regime is compared with experimental results obtained by means of a mass transfer analog to the thermal system. (J.R.D.)

43151 DESTRUCTION OF SUPERFLUIDITY CAUSED BY HEAT TRANSPORT FROM A HOT WALL THROUGH A WIDE TUBE TO A BATH OF LIQUID HELIUM II. Clement, B. W.; Frederking, T. H. K. (Univ. of California, Los Angeles). pp 299-305 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.1).

Heat transport through a vacuum-insulated short tube of large diameter (0.4 in.) to bulk liquid He(II) (1.75°K to the λ-point) has been studied when superfluidity is destroyed locally by film boiling. Heat was applied at constant power through a horizontal surface terminating the tube at its lower end. The heat transfer coefficients (0.014 to 0.027 W/cm²°K) were a function of the length (about 0 to 10 in.) of the bulk liquid heat path. They increased upon lowering of the liquid temperature in approximate agreement with expectation based upon the apparent thermal conductivity of He(II). (auth)

43152 TURBULENT HEAT TRANSFER FROM SLURRY WITH INTERNAL HEAT GENERATION. Michiyoshi, Itaru (Kyoto Univ.); Matsumoto, Ryuichi. pp 398-408 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume I. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.1).

An analysis is presented of fully developed turbulent heat transfer from Bingham plastic fluid, whose Prandtl numbers are in the region between 1 and 8, with uniform internal heat generation in the case of uniform heat flux at wall of circular tube. The Nusselt number of Bingham plastic fluid is discussed comparing with that of Newtonian fluid with or without internal heat generation. (auth)

43153 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7–12, 1966. VOLUME II. New York, American Institute of Chemical Engineers, 1966. 381p. (CONF-660801–(Vol.2)).

A total of 40 papers presented at the conference is included in volume two. Separate abstracts were prepared for two papers. Papers for which no abstracts were prepared are concerned with forced and natural convection heat transfer, and heat transfer in condensation. (J.R.D.)

For abstracts of individual papers see: 43154 and 43155.

43154 EXPERIMENTAL INVESTIGATION OF NATURAL CONVECTION IN SINGLE AND MULTIPLE VERTICAL ANNULI WITH HIGH PRESSURE CARBON DIOXIDE. Sheriff, N. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 132-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume II. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.2).

An investigation was undertaken to measure the natural convective heat transfer coefficients in narrow vertical annuli containing carbon dioxide at pressures up to 50 atmospheres. The properties of single annular gaps were studied, and configurations with annular gaps were sub-divided laterally. The annular gaps for the single annuli were 0.300, 0.150, and 0.050 in., and the annulus which was subdivided was that with a gap of 0.300 in. The results for the single gaps have been correlated in the form: $Nu_t = A\,(Gr_t\,Pr)^{0.30}\,(H/t)^{-0.25}$. For the multiple gaps, although improvement in insulating properties is significant, the magnitude is not as large as expected from analysis. (auth)

43155 CONDENSATION OF SODIUM AT HIGH HEAT FLUXES. Barry, R. E.; Balzhiser, R. E. (Univ. of Michigan, Ann Arbor). pp 318-28 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume II. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.2).

Sodium was condensed on the outside of a vertical, ½-in.-dia tube, internally cooled by flow of liquid potassium at heat fluxes of from 215,000 to 583,000 Btu/hr-sq ft. The vapor temperature was varied from 1240 to 1525°F providing a five-fold variation in the vapor density. The sodium condensing coefficient appeared to be constant at 10,800 ± 3300 Btu/hr-sq ft-°F. This value agrees with previous data taken at much lower heat fluxes and represents 8 to 10% of the value predicted by Nusselt's theory. (auth)

43156 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7–12, 1966. VOLUME III. New York, American Institute of Chemical Engineers, 1966. 320p. (CONF-660801–(Vol.3)).

A total of 23 papers presented at the conference is included in volume three. Separate abstracts were prepared for eight of the papers. Papers for which no abstracts were prepared are concerned with mass transfer, single-phase flow, burnout, pool boiling, and extended heat transfer surfaces. (J.R.D.)

For abstracts of individual papers see: 43157–43164.

43157 THE EFFECT OF AXIAL HEAT FLUX DISTRIBUTION ON CRITICAL HEAT FLUX IN ANNULAR, TWO-PHASE FLOW. Todreas, N. E. (Atomic Energy Commission, Washington, D. C. Catholic Univ., Washington, D. C.); Rohsenow, W. M. pp 78-85 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.3).

An investigation of the effect of nonuniform axial heat flux distribution on critical heat flux was performed with water in the quality condition. Data were obtained for flux distributions representing cosine, linear increasing and decreasing, inlet and exit peaked, spike, and uniform shapes. Utilizing a model which ascribes the critical condition to either a nucleation induced disruption of the annular liquid film or annular film dryout, the results taken at 50 to 200 psia were confirmed. It is proposed that the occurrence of the critical condition is related to the local degree of nucleation (the ratio of the local flux to the flux required to cause nucleation at the local conditions) and the local film flow rate. Application of this model to higher pressure conditions indicated qualitative agreement with available data of other investigators. (auth)

43158 CRITICAL HEAT FLUXES IN INTERNALLY HEATED ANNULI OF LARGE DIAMETER COOLED BY BOILING WATER AT 1000 PSIA. Moeck, E. O. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Matzner, B.; Casterline, J. E.; Yuill, G. K.

pp 86-97 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Critical heat fluxes (CHF) were measured for parameters such as mass velocity 0.5 to 5.0×10^6 lb/hr-ft^2, exit conditions subcooled water to-71% steam by weight, heater diameter 3.0 and 3.8 in., average coolant gap 0.064 and 0.104 in., and uniformly heated length 74.1 in. At constant exit conditions the CHF increased with increasing gap. The highest CHF values occurred in annuli with stripping rings on the unheated wall, the lowest in an eccentric one. Existing correlations predicted 113 experimental CHF values to root mean square deviations from 10.7 to 32.6%. Modifications of them reduced these deviations to 4.2 to 6.7%. (auth)

43159 TWO-PHASE HEAT TRANSFER AND DRY OUT IN A THIN ANNULAR CHANNEL. Pickering, A. (United Kingdom Atomic Energy Authority, Winfrith, Eng.); Shires, G. C.; Rounthwaite, C. pp 98-110 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

A test-section was constructed consisting of two vertical, concentric Inconel tubes. Both tubes were electrically heated and boiling water passed up the narrow annulus between them. Wall temperatures of the exposed surfaces of both tubes were measured at many locations over ranges of the following variables—inlet water subcooling (10 to 200°F), coolant pressure (390 to 930 psig), coolant mass velocity $4-35 \times 10^4$ lb/ft^2 hr), heat flux (below 3 W/cm^2). A few pressure drop readings were also taken. In general the cooling was effective and circumferentially uniform, but under certain conditions it was possible for dry-out to occur at outlet qualities below 70% and for this to spread a considerable distance down the test-section. (auth)

43160 HEAT TRANSFER TO BOILING POTASSIUM IN TUBES. Aladev, J. T.; Gorlov, J. G.; Dodonov, L. D.; Sevastyanov, R. J.; Fedynskii, O. S. (Krzhizhanovskii Power Inst., Moscow). pp 123-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Results of studies of critical heat flux and heat transfer with boiling potassium in tubes (P = 1.1 to 1.3 bar) and critical heat flux with boiling water in tubes (P = 1.7 bar) are presented. The effects of mass velocity, heat length–dia ratio, and nonuniform axial heat flux distribution on critical heat flux was investigated. The resulting data with boiling potassium and water are compared, and test equipment design procedures are recommended. (auth)

43161 DNB MEASUREMENTS FOR UPWARDS FLOW OF WATER IN AN UNHEATED SQUARE CHANNEL WITH A SINGLE UNIFORMLY HEATED ROD AT 1600 TO 2300 PSIA. Larsen, P. S.; Kitzes, A. S.; Stormer, T. D.; Green, J.; Tong, L. S. (Westinghouse Electric Corp., Pittsburgh). pp 143-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Results are reported for 57 DNB heat flux measurements obtained from a single 0.320 in. OD by 28-in.-long heater rod centered in a 0.510 in. square, unheated channel, for conditions of upwards flow of water at 1600 to 2300 psia pressure, 520 to 600°F inlet temperature, and 0.5 to 3.0×10^6 lb/hr ft^2 mass velocity. A comparison is made with existing DNB correlations, among which the Westinghouse modified W-3 correlation yields good agreement, predicting the measured DNB heat flux within +15% and –10%. (auth)

43162 TRANSIENT BOILING OF WATER AT ATMOSPHERIC PRESSURE. Hall, W. B.; Harrison, W. C. (Univ. of Manchester, Eng.). pp 186-92 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Rapid power transients in nuclear reactors raise the question of the mechanism of boiling when the heat flux into the water increases exponentially with time. There are reasons for expecting that this mechanism may change radically when the period of the exponential reaches about 1 msec, and experiments were made which extend the published information from periods of about 5 msec down to about 0.7 msec. It is evident from the results that, even at the lowest periods tested, a short burst of nucleate boiling precedes film boiling; during this burst heat fluxes of several kilowatts per cm^2 were measured. These heat fluxes exceed, by a factor of between 5 and 10, the burnout heat fluxes for steady pool boiling under similar conditions of sub-cooling. A proposed micro-layer vaporization mechanism could reasonably explain the magnitude of the heat flux. (auth)

43163 THEORETICAL AND EXPERIMENTAL STUDIES ON THE HEAT TRANSFER AND PRESSURE DROPS ALONG SURFACES FITTED WITH HERRINGBONE FINS. Peice, J.; Malherbe, J.; Pierre, B. (CEA, Saclay, France). pp 254-71 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Several among the most advanced nuclear power reactors of the graphite-gas type are fueled with magnesium alloy canned metallic uranium fuel elements whose cans are fitted with herring-bone fins. Herring-bone means an alternate disposition of fins bent down on both sides of symmetry axes parallel to the main fluid flow direction. The study of heat exchanges and pressure drops along this type of can was deduced both from the theoretical and experimental viewpoints. It leads to a theoretical formulation of experimentally measured coefficients and explains fairly well the overall results over a wide range of geometrical and aerodynamical parameters. (auth)

43164 A STUDY OF THE HEAT TRANSFER PROCESSES IN BANKS OF FINNED TUBES IN CROSS FLOW, USING A LARGE SCALE MODEL TECHNIQUE. Neal, S. B. H. C.; Hitchcock, J. A. (Central Electricity Research Labs., Leatherhead, Eng.). pp 290-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume III. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.3).

Studies are described that have been carried out to investigate the heat transfer processes occurring within banks of annular finned tubes in staggered arrangement. A large scale model rig has been used to allow detailed study of the airflow and heat transfer processes. Changes of these processes at different positions in the tube bank and for different tube bank arrangements were examined. Boundary layer conditions, local velocities, and turbulence levels have been found to vary considerably over the fin surfaces and accounted for the large variations in heat transfer that were observed. Limitations of this type of surface are discussed. (auth)

43165 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7–12, 1966. VOLUME IV. New York, American Institute of Chemical Engineers, 1966. 358p. (CONF-660801–(Vol.4)).

A total of 39 papers presented at the conference is included in volume four. Separate abstracts were prepared for eleven papers. Papers for which no abstracts were prepared are concerned with pool boiling, thermal conduction, flow boiling, and granular beds. (J.R.D.)

For abstracts of individual papers see: 43166–43176.

43166 FUNDAMENTAL ASPECTS OF SUBCOOLED BOILING WITH AND WITHOUT DISSOLVED GASES. Behar, M.; Courtaud, M.; Ricque, R.; Semeria, R. (CEN, Grenoble, France). pp 1-11 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

The effects of dissolved gas in subcooled boiling (degassing and vaporization) were studied in air saturated water in free and forced convection with visual observation of the heat exchange mechanisms (photography and Schlieren high speed cinematography), stagnant metaterphenyl at 350°C, pressure less than 4 kg/cm^2, gas content between 0 and 26 cm^3/100 g, terphenyl in forced convection at 350 to 400°C, 5 to 9 kg/cm^2 pressure, 4 to 10 meters per second convection velocity, and 10 to 70 cm^3/100 gas content. Degassing improves the heat exchange without increasing the pressure drop as long as the wall temperature is lower than the saturation temperature of the degassed liquid. In subcooled boiling of degassed water, histograms of bubble dimensions are obtained by a photographic method. They can be considered as the superposition of two distribution curves: the first one corresponds to isolated bubbles, the second one to agglomerated bubbles. Heat exchange mechanisms observed by Schlieren method are briefly recalled. (auth)

43167 POOL BOILING RESPONSE TO PRESSURE DECAY. Tanger, G. C. (Auburn Univ., Ala.); Vachon, R. I.; Pollard, R. B. pp 38-43 of Proceedings of the Third International Heat Transfer

Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

The history of liquid superheat in a pool boiling system subjected to a sudden pressure release is presented. A 304 stainless steel heater surface in contact with distilled degassed water was monitored during system pressure decay through a 1.00-in. orifice to the atmosphere. The data show that the liquid superheat reaches a maximum during the initial transient pressure phase and becomes negative during the final transient phase with release time of approximately 12 seconds. This phenomenon has not received extensive publication in the literature and yet is quite probable in cryogenic systems. (auth)

43168 PROBE CONSTANT FOR IN-SITU DETERMINATION OF THERMAL CONDUCTIVITIES OF SOILS. Hsu, S. T.; Kao, H. S.; Lee, W. W. (Virginia Polytechnic Inst., Blacksburg). pp 81-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

In using a heated probe of finite diameter for the in situ determination of thermal conductivities of soils, the theory of line heat source can not be directly applied. Consequently, the energy equation must be modified. The probe actually replaces a small core of the specimen. A method has been found to compensate for the difference in heat dissipation between the instrument and the displaced core. Each probe is given a constant for a specific range of thermal conductivity and moisture content. By inserting the constant in the equation for the line heat source, accurate results have been obtained. (auth)

43169 CONTACT CONDUCTANCE MEASUREMENTS DURING TRANSIENT HEATING. Schauer, Dale A. (Univ. of California, Livermore); Giedt, Warren H. pp 100-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

An experimental method is described for determining the interface conductance between two plates during transient heat transfer. The technique is based on heating one plate in about 100 μsec with a capacitor-bank discharge and then recording the contacting-surface temperatures of the two slabs as they come to equilibrium. Results are presented for combinations of: (1) aluminum and stainless steel with contact-surface finishes of 5–5 μin. AA (arithmetic average), 12 to 30 AA, 15 to 38 AA, and 50 to 35 AA; and (2) stainless steel and ceramic with contact-surface finishes of 31 to 38 AA, and 64 to 38 AA. The pressure was varied from 100 to 2000 psi. For metallic contacts the conductance increased about 200% with time. The reverse behavior occurred with the metal-ceramic contacts. (auth)

43170 ON THE RELATIONSHIP BETWEEN THE PHASE DISTRIBUTIONS AND RELATIVE VELOCITIES IN TWO-PHASE FLOW. Petrick, Michael (Argonne National Lab., Ill.); Kudirka, A. A. pp 184-92 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

Two-phase void fractions and phase distributions in developing and fully developed two-phase flow were studied in an air-water system and in a high pressure steam-water system using the gamma-attenuation. The phase distributions in developing flow were different from those in fully developed flow. In developing flow, slip ratios were generally less than one and increased as the mixture quality increased and the velocity decreased. In developed flow, the void distributions became more skewed as velocity increased and quality decreased. The experimental results were also compared with the physical bases of Bankoff's, and Zuber's and Findlay's models. (auth)

43171 AN ANALYSIS OF THE STEADY STATE AND STABILITY CHARACTERISTICS OF A NATURAL CIRCULATION BOILING CHANNEL. Spigt, C. L.; Dijkman, F. J. M.; Tummers, J. F.; Bogaardt, M. (Technological Univ. of Eindhoven, Netherlands). pp 193-206 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

Stability in vertical boiling channels in which heat is generated by electrically heated elements and transferred to water circulating by natural convection under pressures up to 30 atm is analyzed. Studies were conducted on the static performance as well as the dynamic characteristics of boiling channels. The aim of the static program is to yield correlations for slip and pressure drop in two-phase flow. This program led to the establishment of conditions under which instabilities start and to the prediction of the stability characteristics of the steady state by hand of transfer functions. The mathematical model by Jahnberg is used for comparison with experimental results. (auth)

43172 AN APPROXIMATE ESTIMATION OF CIRCULATION AND TEMPERATURE CHARACTERISTICS OF TWO-PHASE PULSATION FLOWS WITH SURFACE BOILING. Styrikivich, M. A.; Nevstrueva, E. I. (Moscow Power Inst.). pp 207-15 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

Investigations of hydrodynamics and heat transfer during pulsation in steam generating tubes operating with surface boiling are reported. The necessity of additional measurements and recording of instantaneous values of volumetric vapor contents and their variation along the channel length is substantiated. Results of measurements are presented and a method of estimating the quantity of vapor (by weight) and the mean subcooling of the liquid phase for flows resembling a slug flow pattern is suggested. It is also shown that actual flow rate vapor content by weight with surface subcooled boiling in a long tube considerably exceeds the steam quality estimated by heat balance. The mean temperature of the liquid phase may be by a few degrees lower than the saturation temperature. The results shed new light on the mechanism of pulsation and burnout in subcooled boiling of water. (auth)

43173 PROPAGATION OF DENSITY DISTURBANCES IN AN AIR–WATER FLOW. Nassos, G. P. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Bankoff, S. G. pp 234-46 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

The behavior of density disturbances in an air-water flow was measured by local resistivity probes. The disturbances were introduced into an established air-water flow by periodic secondary air injections. The experimental wave velocities are in fair agreement with the one-dimensional kinematic wave theory, based upon the work of Lighthill and Whitman, but this theory does not adequately predict the perturbation growth and decay rates. A modification, taking into account turbulent diffusion, is developed. (auth)

43174 SYSTEM-INDUCED INSTABILITIES IN FORCED-CONVECTION FLOWS WITH SUBCOOLED BOILING. Maulbetsch, John S.; Griffith, Peter (Massachusetts Inst. of Tech., Cambridge). pp 247-57 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

A study of system-induced instabilities of forced-convection flows with boiling is reported that is restricted to the case of water flow in $<\frac{1}{4}$ in. circular channels, at high L/D ratios, moderate temperatures and pressures, and primarily directed toward subcooled boiling. Both excursive and oscillatory instabilities were analyzed using a linearized, lump-parameter model, characterized by steady-state quantities. The energy storage mechanism for the oscillatory behavior was fluid inertia and system compressibility. The stability criteria were found to be dependent on a critical slope of the pressure drop-flow rate curve. The analytical predictions were checked on a single tube apparatus with controlled compressibility and good agreement was obtained. Similar agreement was found in comparisons with stability data in the literature. (auth)

43175 ON HEAT TRANSFER AND CRITICAL HEAT FLUX IN ORGANIC COOLANTS AND THEIR MIXTURES BOILING. Sterman, L. S.; Vilemas, J. V.; Abramov, A. I. (Moscow Power Inst.). pp 258-70 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.
See CONF-660801–(Vol.4).

Results of heat transfer and critical heat flux investigation in pool and surface boiling are presented for a number of organic liquids (diphenyl, monoisopropyldiphenyl, Dowtherm, and others) and diphenyl-benzene mixtures. Experimental data obtained on uniform mediums are correlated with the known generalized relationships. New generalized relationships for determining critical heat fluxes and heat transfer coefficients are proposed to generalize properly all the data available. (auth)

43176 MEASUREMENT OF LOCAL HEAT TRANSFER FROM A SPHERE IN AN ARRAY. Lawther, K. R.; Szomanski, E.

(Australian Atomic Energy Commission, Sidney). pp 336-43 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume IV. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.4).

The effects of neighboring spheres on the local convective heat transfer profile of single spheres were assessed using 3-in. copper spheres instrumented with heater and thermal flux metering inserts. Profiles of local surface heat transfer coefficients were obtained using arrangements in which the single spheres were mounted in arrays of 3-in. wooden spheres and air flows at Reynolds numbers (based on sphere dia) of approximately 50,000. The effects of neighboring spheres were found to depend on their proximity and angular position relative to the stream. The profile is modified in the region of points of contact or near contact. (auth)

43177 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7–12, 1966. VOLUME V. New York, American Institute of Chemical Engineers, 1966. 265p. (CONF-660801–(Vol.5)).

A total of 26 papers presented at the conference is included in volume five. Separate abstracts were prepared for nine papers. One paper on boiling Na heat transfer was previously abstracted as NSA 21: 5702. Papers for which no abstracts were prepared are concerned with aspects of flow boiling and thermal radiation. (J.R.D.)

For abstracts of individual papers see: 43178–43186.

43178 DISCHARGE OF SATURATED WATER THROUGH PIPES AND ORIFICES. Uchida, Hideo; Nariai, Hideki (Tokyo Univ.). pp 1-12 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Saturated or subcooled water at 8 kg/cm^2 pressure was discharged to atmosphere from a pressure vessel through pipes of 4 mm ID by 0 to 2500 mm long. Flow rates, flow patterns, and pressure profiles along both long and short pipes were measured. Flow patterns of flashing water in a glass tube were observed by high speed camera. The pressure gradient at the exit of long pipe was finite and the pressure along the short pipe was constant. The flow pattern upstream of the pipe exit was froth flow. (auth)

43179 TWO-PHASE PRESSURE LOSS ACROSS ABRUPT CONTRACTIONS AND EXPANSIONS, STEAM–WATER AT 600 TO 1400 PSIA. Janssen, Earl (General Electric Co., San Jose, Calif.). pp 13-23 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

The two-phase pressure drop was measured for several contraction and expansion geometries, using steam and water at the following conditions: pressure, 600 to 1400 psia; mass flux, 0.25×10^6 to 2.0×10^6 lb/hr·ft^2; quality, 0 to 90%; and flow orientation, vertical upward, horizontal, vertical downward. High speed moving pictures were taken of the flow pattern. Models were developed that predict values for the pressure loss across contractions and expansions which are in good agreement with measured values. (auth)

43180 VAPOR VOID FRACTION IN SUBCOOLED BOILING AND IN SATURATED BOILING SYSTEMS. Zuber, N.; Staub, F. W.; Bijwaard, G. (General Electric Co., Schenectady, N. Y.). pp 24-38 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

The results of an analysis for predicting the vapor void fraction in boiling systems are presented. For two-phase systems in thermodynamic equilibrium it was shown that effects of flow profile, of vapor concentration profile across the duct and of relative velocity must be taken into account. It is shown that when the bulk liquid is either subcooled or superheated the effect of the non-uniform liquid temperature distribution, must be considered. These four effects are included in an analytical expression for predicting the void fraction in saturated or subcooled boiling. A method for also taking into account the nucleating characteristics of the heated surface is given since this effect also influences the non-equilibrium void prediction. Satisfactory agreement is shown between the analytical results and experimental data. (auth)

43181 FILM BOILING INSIDE HORIZONTAL TUBES. Kruger, Robert A. (General Atomic Div., General Dynamics Corp., San Diego, Calif.); Rohsenow, Warren M. pp 60-8 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Film boiling was studied for stratified flow of Refrigerant-113 in horizontal tubes. Because the flow conditions were not uniform around the circumference (vapor along the top and film boiling liquid along the bottom, the overall average heat transfer coefficient was deemed valueless. An analysis for predicting temperature distribution on the true surface is presented, the results of which compare favorably with the experimental data. (auth)

43182 STUDY OF SODIUM BOILING HEAT TRANSFER. Petukhov, B. S.; Kovalev, S. A.; Zhukov, V. M. (Moscow Power Engineering Inst.). pp 80-91 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Study of sodium boiling heat transfer from surfaces of horizontal tubes under natural convection was made. The measurements include the pressure range from 8 to 600 mm Hg and heat flux range from 10^5 to 1.5×10^6 kcal/m^{2}hr. Heat transfer coefficients versus pressure and heat flux have been obtained. The results of measurements are compared with other experimental data. Bubble formation conditions on the heating surface have been considered. It has been shown that when the critical radius of nucleating bubble is large and wetting angle is small the heater surface temperature is subjected to pulsations and that sometimes boiling changes to natural convection regime. (auth)

43183 UNIFORM FLOW OF A RADIATING GAS OVER A FLAT PLATE. Pai, S. I. (Univ. of Maryland, College Park); Tsao, C. K. pp 129-37 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Results of a study of uniform flow of high temperature gases over semi-infinite flat plates such that the radiative heat transfer is of the same order of magnitude as those heat transfers by conduction and by convection are presented. It was found that when the radiative heat transfer is large in comparison with the heat conduction, the thickness of the thermal boundary layer will be so large that the ordinary boundary layer approximations may not be valid for the energy equation. The problem for the optically thick medium is examined using the Rosseland expression. It was found that the cold plate produces an upstream thermal wake. The temperatures upstream as well as over the plate are presented. (auth)

43184 AN INVESTIGATION OF RADIANT HEAT TRANSFER IN CLUSTERS OF PARALLEL RODS. Fisher, S. A.; Cowin, M. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 174-83 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Methods are given for calculating radiant heat transfer in parallel rod bundles. The calculation procedure is based on the work of Eckert et al., and the surfaces of the assembly, assumed grey are represented by discrete areas. It is shown how matrix inversion may be used when the configuration is fixed to obtain more general solutions applying to any heat flux or temperature distribution. Comparisons are made with experimental data obtained using apparatus designed for this purpose for polished and oxidized surfaces, at 400 to 700 °C and for uniform and non-uniform heat generation. (auth)

43185 SOME PROBLEMS ON HEAT TRANSFER IN PLASMA JET GENERATORS. Borovchenko, E. A.; Krylovich, V. I.; Yasko, O. I. (Heat and Mass Transfer Inst., Minsk). pp 228-35 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801–(Vol.5).

Methods of calculating heat and mass transfer between electric arcs and heat absorbing substances as well as heat transfer to the electrodes and walls of plasmatron discharge chambers are presented. Methods of increasing plasmatron efficiency and safety are discussed. (J.R.D.)

43186 MAGNETOHYDRODYNAMIC HEAT TRANSFER IN A FINITE DUCT WITH FULLY DEVELOPED FLOW CONDITIONS. Eraslan, A. H.; Snyder, W. T. (Univ. of Tennessee, Tullahoma). pp 236-45 of Proceedings of the Third International Heat Transfer Conference, Chicago, Illinois, August 7–12, 1966. Volume V. New York, American Institute of Chemical Engineers, 1966.

See CONF-660801-(Vol.5).

The general problem of magnetohydrodynamics heat transfer in finite ducts is formulated for fully developed flow conditions with an arbitrarily oriented applied magnetic field and variable heat flux boundary conditions on the surface contour of the cross section. From the general formulation, an exact solution is obtained for a rectangular region by the method of finite Fourier transforms. Numerical results are presented for two cases of thermal boundary conditions for various values of the characteristic parameters of the problem. (auth)

43187 PROCEEDINGS OF THE THIRD INTERNATIONAL HEAT TRANSFER CONFERENCE, CHICAGO, ILLINOIS, AUGUST 7–12, 1966. VOLUME VI. New York, American Institute of Chemical Engineers, 1966. 371p. (CONF-660801-(Vol.6)).

Discussions concerning the conference are presented. Included are reporters remarks, authors rebuttals, and errata. Also included are the contents of four invited lectures. A list of papers for which discussions are presented is included along with pertinent additional data. No other abstracts were prepared for this volume. (J.R.D.)

43188 VOID DETECTION UTILIZING NEUTRON ATTENUATION. Bouilla, C. F.; Sha, W. T. (to U. S. Atomic Energy Commission). U. S. Patent 3,350,564. Oct. 31, 1967.

A method is described for measuring the void fraction of boiling water utilizing neutron attenuation. A small amount of a neutron absorbing material such as boron is dissolved in the water to magnify the differential neutron absorbing qualities of the liquid and vapor fractions of the boiling water. A neutron source is implanted to produce a beam of neutrons at a low, uniform energy. (AEC)

43189 METHOD AND APPARATUS FOR INCREASING BURNOUT HEAT FLUX IN REACTOR PRESSURE TUBES. (to Atomic Energy of Canada Ltd.). British Patent 1,083,837. Sept. 20, 1967. Priority date Aug. 21, 1964, Canada.

A nuclear reactor fuel assembly is described in which burnout heat flux is considerably raised by wrapping the fuel bundles with a series of rings that will expand and spring out against the pressure tube to block the flow of coolant water along the pressure tube and direct it toward the fuel elements in the fuel bundles. (F.S.)

43190 VERTICAL TUBE ONCE-THROUGH STEAM GENERATOR. Williamson, Malcolm Richard; Chamberlain, Michael Joseph (to United Kingdom Atomic Energy Authority). British Patent 1,084,228. Sept. 20, 1967. Filed Oct. 7, 1964.

A vertical tube once-through vapor generator for use in integrated nuclear reactor steam generator systems is described. The heating surface consists of a number of once-through tube clusters exposed to a heating fluid. Each cluster consists of lower and upper headers divided into two chambers, evaporator tubes extending upward, and superheater tubes extending downward so that in-fed water can be removed as superheated steam. (F.S.)

Isotope Technology

Refer also to abstracts 43188 and 43207.

43191 (CEA-R-3211) ENRICHISSEMENT D'UN MELANGE BINAIRE PAR ECOULEMENT A TRAVERS UNE PAROI MICROPOREUSE. (Enrichment of a Binary Mixture by Passage Across a Microporous Wall). Marty, Claude (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 48p. (In French). Dep.

The diffusion of a gas or a vapor in permeable media having small pore radii is discussed. Enrichment phenomena during the diffusion of binary mixtures across porous membranes is of great importance in the industrial development of uranium isotope separation. The laws governing the molecular flow of perfect gases have been established and checked satisfactorily by experiment. Results concerning the separation of binary mixtures at relatively high pressures are unpredictable. It is impossible to elucidate the separation mechanism without a prior knowledge of the gas-solid interface. An experimental study of the adsorption phenomena has been undertaken to determine the textural characteristics of the porous body and the state of the adsorbed molecules. Various dynamic tests involving diffusion of the vapor or liquid phase flow of a binary azeotropic mixture show the importance of the adsorbed phase. (auth)

43192 (ORNL-IIC-9) LIST OF AEC RADIOISOTOPE CUSTOMERS WITH SUMMARY OF RADIOISOTOPE SHIPMENTS, FY 1966. Baker, P. S. (comp.) (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

Alphabetical listings are presented of domestic and foreign radioisotope customers; isotopes purchased with suppliers indicated; isotope shipments, including quantities; and states and countries where shipments were made cross referenced to customer numbers. (F.S.)

43193 (SC-DC-67-1900) AEROSPACE NUCLEAR SAFETY. Blake, V. E. Jr. (Sandia Corp., Albuquerque, N. Mex.). July 1967. Contract AT(29-1)-789. 14p. (CONF-670714-6). Dep. CFSTI.

From 2nd International Symposium on Nucleonics in Aerospace, Columbus, Ohio.

Future developments in space will be governed largely by the amount of power that can be carried there for use. One of the most promising sources of power is from the decay of radioactive isotopes. Although power levels are not high (that is, generally below 1000 watts electrical), the reliability and long life of these systems are indeed attractive. The challenge of the future is to increase the specific power of these systems, and at the same time to increase the overall safety. The problem concerned with increasing aerospace nuclear system safety is discussed. (auth)

43194 (STL-517-0049(Vol.2B)(Add.)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). ADDENDUM TO VOLUME IIB. PROGRAMMER'S AND USER'S MANUAL FOR ANALYTICAL PROGRAM FOR CREEP IN AXISYMMETRIC BODIES (CRAB). Final Report, October 1, 1965–September 30, 1966. Greenbaum, Gilbert; Adams, Richard (TRW Systems, Redondo Beach, Calif.). Oct. 1966. Contract AT(04-3)-517. 55p. Dep. CFSTI.

Analytical procedures for describing the creep behavior of thick-walled pressure vessels were developed as part of the Poodle Program. The CRAB computer program resulting from this effort and which provides a history of the stresses and creep strains in any axisymmetric vessel is described in this programmer's and user's manual. CRAB is applicable for axially varying wall thicknesses and for any symmetrical end-closure. It is also applicable in the presence of temperature gradients and for time-dependent pressures and temperatures. (L.C.L.)

43195 (STL-517-0049(Vol.4)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME IV. PERFORMANCE OF LOW THRUST NOZZLES. Final Report, October 1, 1965–March 31, 1967. (TRW Systems Group, Redondo Beach, Calif.). Apr. 1967. Contract AT(04-3)-517. 112p. Dep. CFSTI.

The maximum performance to be expected for low-thrust nozzles operating at nominal Poodle conditions was determined analytically and verified by testing. The compressible laminar boundary layer within low-density supersonic diverging nozzles was analyzed in order to predict the specific impulse and efficiency of nozzles having arbitrary geometry and stagnation conditions. The viscous-inviscid interaction problem and axial Mach number distribution were treated by applying previous analyses and experimental data. Having determined the nature of the flow within the nozzle, the nozzle performance characteristics were calculated. A parametric study of nozzle configurations was then performed to determine the influence of nozzle geometry, gas composition, stagnation temperature, and throat Re on the performance characteristics. A maximum nozzle efficiency of 95% was predicted. The performance of the nozzle configurations used in the analysis was determined experimentally. Maximum efficiency was approximately 89%. It is concluded that for a Poodle thruster operating at a stagnation temperature of 3600°F and chamber pressure of 15 psia, the optimum conical nozzle should have a half angle of 20° and an area ratio of about 100. Under these conditions the overall nozzle efficiency will be approximately 87%, corresponding to a specific impulse greater than 700 seconds. (L.C.L.)

43196 (STL-517-0049(Vol.5)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME V. SIMULATION OF HIGH-TEMPERATURE RADIOISOTOPE HEAT SOURCE. Final Report, October 1, 1965–March 31, 1967. Nezgoda, E. L. (TRW Systems Group, Redondo Beach, Calif.). Apr. 1967. Contract AT(04-3)-517. 78p. Dep. CFSTI.

Techniques for simulating radioisotope heat source characteristics using electrical resistance heaters were studied. These were specifically oriented toward configurations and conditions applicable to Poodle heat sources. Two heaters were tested and performed satisfactorily at 2200°C for 30 days. For the split-cylinder heater, which was fabricated by the tungsten vapor-deposition process, the use of appropriate lead insulation and lead contouring along the heater and tapering resulted in a flat axial heater temperature profile. The coiled heater design with

its simplified fabrication also performed effectively. The excellent agreement between test results and analytical predictions for each heater showed that the analytical techniques used were highly satisfactory and could be used reliably in future heater designs. (L.C.L.)

43197 (STL-517-0049(Vol.6)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME VI. POODLE SYSTEMS ANALYSES. Final Report, October 1, 1965-March 31, 1967. King, M.; Simms, R.; Stansel, J. C. (TRW Systems Group, Redondo Beach, Calif.). Apr. 1967. Contract AT(04-3)-517. 118p. Dep. CFSTI.

Poodle thruster system analyses are presented. These include analyses of the capsule design, thruster design, re-entry configurations, and a performance comparison of the advanced upper stages for potential NASA missions. (L.C.L.)

43198 STUDY OF THE MIGRATION OF RADIOELEMENTS IN A TUBE WITH A TEMPERATURE GRADIENT. Merinis, J.; Bouissieres, G. (Institut de Physique Nucleaire, Orsay, France). Chem. Zvesti, 21: 625-8(1967). (In French).

In order to study the mechanism of migration of a chemical compound in a quartz tube filled with a carrier gas, an apparatus was constructed consisting of a metallic tube of which one end was heated 600 and 1200°C and the other maintained at 60°C. The migration law of radioelements was established which is of the form $t = Ke^{Q/RT_m}$, where t is the time of migration, T_m is the absolute temperature of the zone corresponding to the position at the time t of maximum deposit, Q is the molar heat of absorption of the compound studied on quartz, R is the gas constant, K is a constant. This method has been applied to the separation and purification of radioelements. (tr-auth)

43199 ENRICHMENT OF NATURAL AND RADIOACTIVE KRYPTON ISOTOPES IN A SEPARATION TUBE. Meinrenken, J. (Univ., Zurich). Z. Naturforsch., 22a: 1261-6(Aug. 1967). (In German).

The effects of pressures up to 760 torr, temperatures between 1050 and 2050°K, and tube diameters between 7.1 and 12.4 mm on the separation of a mixture of natural krypton isotopes in a separation tube were measured. A diameter of 8 mm was found to be most suitable. In an arrangement of 12 tubes with a total length of 40 m the behavior of krypton isotopes, especially the enrichment of the middle isotopes, was studied. (M.C.G.)

43200 PARADOX OF TEMPERATURE EFFECTS IN SEPARATION TUBES. Meinrenken, J. (Univ., Zurich). Z. Naturforsch., 22a: 1266-9(Aug. 1967). (In German).

The paradox consists of the fact that the separation curves lnQ(p) for various temperatures intersect. In the pressure region below the point of intersection the higher temperatures correspond to the greater energy consumption of a poor separation. Theoretical studies agreed well with experimental observations on krypton isotopes and other systems. The temperature dependence of the thermal-diffusion factor was calculated. Conditions for the intersection of temperature curves for varying tube radii were derived. (tr-auth)

43201 IMPROVEMENTS IN OR RELATING TO METHODS AND APPARATUS FOR TREATING SEWAGE. Mitchell, Keith James (to General Electric Co., Ltd.) British Patent 1,079,632. Aug. 16, 1967. Filed Mar. 30, 1965.

A method for treating raw sewage is described in which colloidally suspended materials are precipitated by ionizing radiation produced by gamma rays emanating from cooling fuel elements. (F.S.)

43202 RADIOISOTOPE EXPERIMENTS FOR SCHOOLS AND COLLEGES. Dance, J. B. Oxford, Pergamon Press, 1967. 212p. 17s. 6d.

Section headings are as follows: fundamentals; measurement of nuclear radiation; naturally occurring radioisotopes; health physics; some practical considerations; some demonstration experiments; experiments using naturally occurring radioisotopes; experiments using sealed sources; and experiments using unsealed artificially produced isotopes. (UK)

43203 RADIOISOTOPE THERMOELECTRIC APPARATUS AND FUEL FORM. Banks, Hampden O. Jr.; Teatum, E. T.; Jones, I. R. (to U. S. Atomic Energy Commission). U. S. Patent 3,347,711. Oct. 17, 1967.

An apparatus is described for generating electrical power from an encapsulated radioisotope enclosed in a heavy metal heat generating radiation shield which, in turn, is arranged in a reflective heat shield and has thermal insulation to direct heat flow through one flat end of the radiation shield. Thermo-junction elements are arranged in a heat conductance path between the flat shield end and an exterior shell heat dissipator. Power storage or energy modifying means may also be arranged in this shell. (AEC)

43204 GENERATION AND INDUSTRIAL UTILIZATION OF SOFT X RAYS FROM ISOTOPE SOURCES. Florkowski, Tadeusz. Krakow, Mining and Smelting Academy, 1965. (In Polish). Thesis.

The principles of the construction of isotope x-ray sources are discussed, taking into account the spectrum of the radiation generated, yields, and other physical parameters. The methods of detection and spectrometry of x-radiation using proportional radiation detectors or threshold and differential filters are described. Examples are given of the application of x-radiation from isotope sources in thickness measurements, and fluorescence and absorption analysis of industrial materials. Safety precautions for working with beta- and x-ray sources are given, and a method for calculating the requisite shielding is proposed. The possibility of constructing field isotope instruments for the fluorescence analysis of metal ores is considered. (JPRS)

Materials Testing

Refer also to abstracts 43194, 43294, 43302, and 44968.

43205 (CEA-R-3227) CONTROLE DES INSTALLATIONS D'EPURATION DE L'AIR ESSAIS DE CONFORMITE DES ELEMENTS: TESTS IN SITU. (Testing on Air Cleaning Systems: Testing of the Components In-Place Tests). Billard, Francois; Brion, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). June 1967. 46p. (In French). Dep.

The reliability of air cleaning systems is dependent on the testing to which they are submitted. Although, in-place tests are important since they act as final tests, component tests are necessary as they detect defective units before installation. Material tests are also useful. Various tests are described for aerosol filters and iodine traps. Features of air cleaning systems such as nature of materials, unit sizes, efficiency, air resistance, flammability, humidity resistance, temperature resistance, and absorbent friability. On iodine trapping systems, small check traps, working in by-pass with the main trap are periodically subjected to efficiency tests. This by-pass method of testing is useful when the presence of organic vapor poisoning is suspected. (F.S.)

43206 (SCL-DR-67-60) MAGNETIC ACCELERATION OF FLYER PLATES FOR SHOCK WAVE TESTING OF MATERIALS. Jacobson, R. S. (Sandia Corp., Livermore, Calif.). Sept. 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

A method is described by which shock waves are induced in materials through the impact of magnetically accelerated metal flyer plates. A discussion of the principles involved, a description of the equipment, and sample results are included. (auth)

43207 (STL-517-0049(Vol.1)) RADIOISOTOPE PROPULSION TECHNOLOGY PROGRAM (POODLE). VOLUME I. CAPSULE CREEP STRAIN MEASUREMENTS AND ANALYSES. Final Report, October 1, 1965-March 31, 1967. Lurie, H. (TRW Systems Group, Redondo Beach, Calif.). Apr. 1967. Contract AT(04-3)-517. 146p. Dep. CFSTI.

To validate analytical methods used in designing Poodle capsules and to verify basic assumptions involved in the analytical predictions of creep strain under three-dimensional stress, creep tests of subscale Poodle capsules were performed. Twenty-two $\frac{1}{4}$-scale capsules were tested at temperatures ranging from 1600° to 2000°C for durations of either 720 or 1000 hours. Two $\frac{1}{2}$-scale capsules were also tested to check the validity of the scaling law. Capsule pressures were either held constant for the duration of the test or varied in accordance with the pressure buildup expected in isotope-fueled Poodle capsules. Results of the tests were compared with theoretical predictions based on uniaxial creep data available for the capsule materials under consideration. A time-hardening type correlation with a least squares fit of the data was used for this purpose. Predictions of midplane strains agreed well with experimental results. To circumvent excessive creep strain in a Poodle capsule under actual operating conditions, two alternative designs were investigated. The first involved use of a single capsule with tapered wall, and the second involved nonuniform fuel distribution among three capsules. Theoretical analyses of temperatures and creep were performed for both these designs. (auth)

43208 THERMAL SHOCK AND FRACTURE IN CERAMICS. Davidge, R. W.; Tappin, G. (Atomic Energy Research Establishment, Harwell, Eng.). Trans. Brit. Ceram. Soc., 66: 405-422(Aug. 1967).

The effects of thermal shock on a range of ceramic materials were investigated by water-quenching, with particular reference to alumina. Two aspects were considered and compared with theoretical proposals: the severity of the shock required to initiate fracture and the amount of cracking produced by a shock of fixed severity. Previously suggested shock parameters are respectively: a thermal stress resistance parameter of the type $\sigma(1-\nu)/E\alpha$, where σ is the fracture stress, ν Poisson's ratio, E Young's modulus and α the coefficient of linear expansion; and a thermal shock damage resistance or toughness parameter of the type U/γ_F, where U is the elastic stored energy produced by the shock and γ_F is the effective surface energy or work of fracture. If cracking is to be avoided, the first parameter provides a valid criterion for selection of materials to resist thermal shock. Once cracking has been nucleated, the second parameter defines the limit of the crack area but does not appear to vary systematically with crack area. Comment is made about the British Standard thermal shock test for alumina. (auth) (UK)

43209 PROGRAMMED TESTING: A METHOD FOR HEAVY PLATE. Scott, John H. (Lukens Steel Co., Coatesville, Pa.). Mech. Eng., 89: No. 10, 44-7(Oct. 1967).

A method is described for electronically programming the heat treatment of standard sized specimens of heavy steel plate to achieve mechanical properties in the specimen identical to those in the plate. Materials testing results are compared with the variable sized 3T specimen method. Advantages of the "Programmed Testing" method are emphasized. (L.C.L.)

43210 ULTRASONIC FLAW DETECTION IN SMALL DIAMETER METAL TUBING. Klindt, K. K. (to U. S. Atomic Energy Commission). U. S. Patent 3,349,607. Oct. 31, 1967.

An ultrasonic detector for detecting flaws in small diameter tubing is described which causes acoustic energy generated in an ultrasonic transducer to be collimated and to fall incident upon the outer surface of a tubular test specimen. A portion of the acoustic energy is refracted and propagated straight through a tubular sector of the specimen to a second point on the outer surface where it is again refracted and detected by a receiving transducer. Flaws are detected by reduction in intensity of ultrasonic pulses passing through a different segment of the specimen as compared to the intensity normally received through a segment of flawless tubing. (AEC)

Protective Structures

Refer also to abstract 43168.

43211 (AD-651349) DYNAMIC TEST OF A MODEL FLEXIBLE-ARCH-TYPE PROTECTIVE SHELTER. REPORT I. PILOT TEST. Kennedy, T. E.; Ballard, J. T. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Apr. 1967. 107p. (TR-1-768). CFSTI.

The general objective of the pilot test reported herein was to determine the response of a small-scale, buried, flexible-arch troop shelter to a simulated nuclear blast overpressure. To accomplish this, a model structure was constructed using a scaling ratio of 1 to 4.5. The model structure was buried in dense, dry sand with depth of cover equal to one-quarter the diameter of the arch. The test was conducted in the Waterways Experiment Station Large Blast Load Generator at an overpressure of about 85 psi. Strain, acceleration, and deflection were measured at various points on the structure along with pressure in the free field and overpressure at the soil surface. The only serious damage observed was a shear failure of the bolt connections between the bulkhead columns and the end trusses. The results of this study will be used to plan further tests of the structure. (TAB)

43212 (AD-651805) ON THE DESIGN OF RISK-ORIENTED, LOW COST FALLOUT SHELTER SYSTEMS. Final Report. Rockett, Frederick C.; Brown, William M. (Hudson Inst., Inc., Harmon-on-Hudson, N. Y.). Mar. 7, 1967. Contract OCD-PS-64-116. 39p. (HI-486/3-RR). CFSTI.

Calculations of minimum required fallout protection which would assure high survival probabilities can be made for each U. S. community. Such calculations would provide a basis for local CD planning to reduce the vulnerability to fallout. If the CD program combined this balanced fallout protection with emergency evacuation from the more vulnerable areas, then the survival potential could become very great in situations which offered a few days or more of strategic warning. The shelter resources in the U. S. and their potential for such a CD program are analysed. (auth) (TAB)

43213 (AD-651944) ACCEPTABILITY OF SHELTER RATIONS IN COMBINATION WITH ADJUNCTS. Interim Report, April 1966-February 1967. Stone, Herbert; Oliver, Shirley M.; Singleton, Richard C. (Stanford Research Inst., Menlo Park, Calif.). Mar. 27, 1967. Contract OCD-PS-64-201. 16p. CFSTI.

Improvement in ration acceptability was approached through the use of adjuncts (flavored spreads) in combination with the rations. Of the 14 adjuncts tested, only 8 were found to be preferable to the ration alone when tasted in a paired-comparison test. The three adjuncts receiving the highest scores (strawberry jelly, wild cherry jelly, and lemon jelly) should be considered for storage in civil defense shelters. These results were based on experiments involving 12 subjects for each of the 42-adjunct-ration combinations. (auth) (TAB)

Radioactive Material Handling

Refer also to abstracts 43016 and 43094.

43214 (AECL-2760) DISPERSION AND DIFFUSION OF STACK RELEASES. Barry, P. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). July 1967. 20p. Dep. CFSTI. CAN $1.00.

A simple introduction to the use of diffusion equations for preparing estimates of environmental concentrations of materials discharged into the atmosphere is given. The equations themselves are derived from first principles with a minimum of mathematics and in such a way as to illustrate both their uses and limitations. (auth)

43215 (AHSB(A)R-6) SYMPOSIUM ON THE TRANSPORT OF RADIOACTIVE MATERIALS, HARWELL, 9TH AND 10TH SEPTEMBER 1963. (United Kingdom Atomic Energy Authority, London (England). Authority Health and Safety Branch). Jan. 1964. 101p. (CONF-630917). Dep. CFSTI. UK.

This symposium was organized by the Authority Health and Safety Branch as a forum for discussing the health and safety aspects of transporting radioactive materials. It embraced the transport both of radioisotopes used in industry, commerce, medicine, agriculture and research and of fuel elements for nuclear research and power reactors. There was an exhibition illustrating the main operational and research and development aspects of the subject. The texts of the talks presented at the symposium, together with a summary of the associated discussions are presented. (L.C.L.)

43216 (BNWL-507) FIXATION OF RADIOACTIVE RESIDUES. Research and Development Activities Quarterly Progress Report, April-June 1967. Platt, A. M. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

Apparently sodium-rare earth element sulfates caused caking and line plugging in Waste Solidification Engineering Prototype (WSEP) pot calcination runs PC-3 and -4. Other solids present in equal volumes did not cake and were easily suspended. Sulfate and borated based compositions of PW-1 and -2 waste were evaluated as low-melting products for in-pot melting and appear promising for PW-2 waste. Haynes LT.1 and LT.1B cermets are being evaluated as candidate materials of construction for waste melters. Design verification tests of phosphate glass equipment were completed and preparations made for radioactive operation. The addition of sodium to PW-1 phosphate glass process feed solutions produces lowered viscosity of concentrated solutions at boiling points (bp) 140 and 150°C. If the additive concentration exceeds 2M, heavy solids which settle rapidly are produced at bp in excess of 140°C. The second spray solidification run (SS-2) succeeded in filling an 8 in. dia container with ceramic solids containing ~400,000 Ci of radioactivity. Use of an internal mixing type of spray nozzle avoided wall accumulation. Work on the developmental spray calciner indicates that melting calcine from a PW-2 flow directly into the storage container is feasible and a vibrating trough solid-feeder provides a satisfactory method of controlling solid flux addition for inpot melting. Despite composition changes in the glass melter condensate generated in phosphate glass cold runs, the scavenging-asphalt incorporation process was not affected and benefits accrue due to reduced final volume. Ion interference studies with hydrous manganese oxide show that under certain conditions, surface exchange adsorption obeys the law of mass action. Theoretical feasibility studies on heat transfer in a container indicate the quantity of heat can be increased by a factor of two, if the container has a molten core. Thus initial water storage of 8 to 12 in. dia containers with a molten core would permit direct processing of 20,000 MWd/t waste in less than 6 months out of a reactor. (F.S.)

43217 (ORNL-TM-1897) DISPERSION OF SIMULATED HIGH-LEVEL RADIOACTIVE WASTE POWDERS IN A GLASS MATRIX. Godbee, H. W.; Davis, N. M.; Shockley, W. E. (Oak

Ridge National Lab., Tenn.). Aug. 4, 1967. Contract W-7405-eng-26. 15p. Dep. CFSTI.

High-level waste powders such as those from the Fluidized-Bed Volatility Process (FBVP) or those from spray calcination of waste solutions from aqueous fuel processing schemes may require some treatment beyond sealing the untreated powder in a disposal pot. These powders may be dispersed (not dissolved) in a glass matrix to yield a two-phase powder-glass system with improved chemical and physical properties. Representative materials from the spray calcination of Purex waste and from the Fluidized-Bed Volatility Process were changed from free-flowing dusty powders to hard, strong, void-free solids by dispersing them in lead-silicate glasses. The thermal conductivity of a FBVP powder in air was 0.25 Btu hr^{-1} ft^{-1} $(°F)^{-1}$ while the thermal conductivity of this powder dispersed in glass was 1.22 Btu hr^{-1} ft^{-1} $(°F)^{-1}$—a fivefold increase in conductivity. The leach rate of ^{137}Cs from this powder was lowered by a factor of 1000 by dispersion in glass. The dispersion process was operated in both a batch and semicontinuous manner using a 2-in.-high type 304 stainless steel pot in a 5-kw furnace. The dispersion process appears intrinsically more flexible and versatile than a process that dissolves the waste solids. Also, dispersions gave volume reductions as good as, or better than, those of solid solutions incorporating the same quantity of waste. (auth)

43218 (BNL-tr-141) CONTRIBUTION TO THE SETTING-UP STANDARDS FOR INERT RADIOACTIVE GASES. Goussev, N. G.; Kochetkov, O. A.; Mikhailov, L. M.; Tourkin, A. D.; Trukhmanova, E. S.; Filipovich, V. P. (Ministerstvo Zdravookhraneniya S,S,S,R., Moscow. Institut Biofiziki). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from a report. 23p. Dep. CFSTI. JCL $2.60 fs, $0.89 mf.

Calculations and experimental data are presented on the distribution of the annual gamma-radiation dose on the ground from the continuous emission of ^{41}Ar from a 100 m chimney within a radius of 20 km. A discrepancy between ^{41}Ar ground concentration and ground gamma dose is shown. Standards of inert radioactive gas emission to the atmosphere are given. Calculated and experimental data on the distribution of the depth of doses of external beta-radiation in tissue-like materials are given and are used for the calculation of maximum permissible concentrations of inert radioactive gases in a working room. These doses proved to be 10 to 15 times more than those recommended by ICRP. Standards for Ar, Kr, and Xe isotope concentration in the atmosphere are based on the total gamma-radiation dose; the main controlling value is the maximum permissible ejection. Standards for working room air are based on the maximum permissible concentration taking into account the volume limitation of the room and consideration of the fact that external radiation dose is determined by the field of the beta particles and conversion electrons. (F.S.)

Vacuum Engineering

Refer also to abstracts 43111 and 43306.

43219 TOTAL PRESSURE MEASUREMENT WITH IONIZATION GAUGES AND THEIR LIMITING FACTORS. van Oostrom, A. (Philips Research Labs., Eindhoven, Netherlands). Vakuum-Tech., 16: 159-67(Sept. 1967). (In German).

Gages based upon the ionization phenomenon are described. Methods used to ionize a gas are discussed: including the radioactive source, surface-ionization, field-ionization, and the most widely applied method, electron impact. For the pressure region over 10^{-5} torr the Schulz–Phelps gage and the Penning gage are described; below 10^{-5} torr the Bayard–Alpert gage and the magnetron gage. Factors which limit the measurement of low pressures are examined. In particular the x-ray limit, desorption phenomena and chemical reactions are discussed. Ionization gages are compared with one another. (auth)

43220 PRODUCTION OF HYDROCARBON-FREE ULTRA-HIGH VACUUM. Hoch, H. Vakuum-Tech., 16: 156-8(Sept. 1967). (In German).

By means of a sputter-ion pump and a titanium evaporator pump ultrahigh vacuum was produced in a 15 litre container. The fore vacuum was produced either by a combination of oil diffusion pump and mechanical pump or by a mechanical pump only. Between these pumps and the container liquid nitrogen cooled traps were fitted. First ultimate pressures in the 10^{-9} torr range were produced without baking. After baking up to 400°C the ultimate pressures obtained were 1.7×10^{-11} torr and lower. After a short-time airing of the apparatus or flooding with dry nitrogen gas and re-evacuating, ultimate pressures of several 10^{-11} torr were obtained without further baking. Only after airing for a period of several days no better ultimate pressures than about 10^{-9} torr were obtainable. During the pumping procedure and at ultimate pressure the gas contents were analyzed by means of an Omegatron. The relevant spectra are reproduced in this study. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 42900, 42964, 43066, 43472, 44645, and 44660.

43221 (AE–294) CHERENKOV DETECTORS FOR FISSION PRODUCT MONITORING IN REACTOR COOLANT WATER. Strindehag, O. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept, 1967. 56p. Dep. CFSTI, SWED.

The expected properties of Cherenkov detectors when used for fission product monitoring in water-cooled reactors and test loops are discussed from the point of view of the knowledge of the sensitivity of these detectors to some beta emitting isotopes. The basic theory for calculation of the detector response is presented, taking the optical transmission in the sample container and the properties of the photomultiplier tube into account. Special attention is paid to the energy resolution of this type of Cherenkov detector. For the design of practical detectors the results from several investigations of various window and reflector materials are given, and selection of photomultiplier tubes is briefly discussed. In the case of optical reflectors and photomultiplier tubes reference is made to two previous reports by the author. The influence of the size and geometry of the sample container on the energy resolution follows from a separate investigation, as well as the relative merits of sample containers with transparent inner walls. Provided that the energy resolution of the Cherenkov detector is sufficiently high, there are several reasons for using this detector type for failed-fuel-element detection. It seems possible to attain the desired energy resolution by careful detector design. (auth)

43222 (AECL–2762) PERFORMANCE OF Ge(Li) DETECTORS OVER A WIDE TEMPERATURE RANGE. Sakai, E.; Malm, H. L.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1967. 36p. (CONF-670520–10). Dep. CFSTI. CAN $1.00.

From Conference on Semiconductor Nuclear Particle Detectors and Circuits, Gatlinburg, Tenn.

The properties of six Ge(Li) detectors as γ-ray spectrometers measured over the temperature range 5 to 220°K are discussed. The detectors were selected to show a wide range of charge trapping effects — three exhibited predominantly electron trapping, two hole trapping, and the other, a very good spectrometer, showed very little trapping of either carrier. Optimum γ-ray energy resolution for all six detectors occurred in the range 20 to 40°K. As the temperature was reduced it was possible to increase the operating voltage giving some further improvement in resolution. Below 20°K the γ-ray resolution deteriorated rapidly due to the appearance of a slow rising component (up to 20 μs) in the preamplifier pulses. With high applied voltage, the slow component disappeared and high-resolution performance was possible down to ~10°K. The detectors were still p-i-n diodes with unchanged sensitive volume (same capacitance) at temperatures down to 5.2°K. Transit times were measured and were strongly temperature dependent having a minimum for both electrons and holes in the range 30 to 60°K. (auth)

43223 (CEA-R–3178) STABILISATEUR DE SPECTRES. (Spectrum Stabilizer). Detourne, Guy (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). May 1967. 38p. (In French). Dep.

A spectrum stabilizer is a control mechanism which renders an analytical chain reliable. It can detect a drift in the amplification and in the base of the energy scale, and can modify the characteristics of this chain. The results of a theoretical study make it possible to calculate the width and the abscissae of the peaks of a stabilized spectrum as a function of the drifts. The spectrostab is a numerical stabilizer of a continuous type; it provides the artificial reference peak at low energies. Experimental results give the performances obtained on a reference peak provided by a semiconductor detector, in the field of gamma spectroscopy. (auth)

43224 (CNAEM–33) A HOME-MADE NEUTRON CRYSTAL SPECTROMETER FOR RESEARCH AND TRAINING. Akyuez, R. O.; Cansoy, C.; Domanic, F. (Cekmece Nuclear Research Center, Istanbul (Turkey)). Nov. 1965. 12p. Dep.

A crystal neutron spectrometer constructed at the Cekmece Nuclear Research and Training Center is described. The energy range is between 0.025–6 eV. The available monochromator single crystals are Be, NaCl, ($CaCO_3$), Pb. The minimum precise rotation of spectrometer is 1 minute of arc in Bragg angle. Two Soller type collimators, one from reactor to crystal and the other from sample to counter, are used. The net angular divergence is approximately 5 minutes of arc. Counting system consists of two channels, one of which is used for monitoring the reactor. Counter tubes are ^{10}B enriched BF_3 proportional counters. The main problem in construction, which was to design and give precise movement to the heavy crystal shielding, is discussed. (auth)

43225 (DPSPU–67–30–5) AECL IN-CORE FLUX MONITORS. Byars, R. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sept. 1967. Contract AT(07-2)-1. 13p. Dep. CFSTI.

Four flux detectors and six cables with different mineral insulations were furnished by AECL for testing at SRP. The cobalt and vanadium detectors operated satisfactorily after an equivalent of one year in a flux of 10^{15} n/cm^2/sec. The Zircaloy detector failed during the first few days of the test. The rhodium detector was damaged beyond repair during fabrication. Current outputs of five of the six cables (2 MgO, 2 Al_2O_3, and 1 BeO_2 insulated) were reproducible throughout the test; one of the cables with BeO_2 insulation gave erratic current output. (auth)

43226 (JAERI–1138) THE NEUTRON TIME-OF-FLIGHT SPECTROMETER AT JAERI LINAC. Asami, A.; Fuketa, T.; Kawarasaki, Y.; Nakajima, Y.; Okubo, M.; Sakuta, T.; Takahashi, K.; Takekoshi, H. (Japan Atomic Energy Research Inst., Tokyo). Apr. 1967. 17p. Dep.

The physical arrangements and characteristics of the neutron time-of-flight spectrometer installation at the JAERI 20-MeV Electron Linac are described. A pulsed neutron beam is produced at a photoneutron target by the linac-electron pulses, whose width is chosen to be of any value from 4 μsec to 40 nsec, and the neutrons are detected, through evacuated flight tubes, by a neutron detector composed of ^{6}Li-glass scintillators at 50 meters from the source target. The flight time of neutrons between the target and the detector is measured by a 4096-channel time analyzer. Characteristics of the neutron detector, spectrum of the neutron beam, background, resolution, monitoring of the neutron beam, data processing, and typical data of the neutron transmission are also reported. (auth)

43227 (JAERI–1140) ORTHONORMAL EXPANSION CODE ACOF FOR ANALYSIS OF NEUTRON SPECTRA AND DOSE EQUIVALENT RATES. Ryufuku, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Apr. 1967. 11p. (In English and Japanese). Dep.

The code ACOF is an IBM 7044 code to obtain neutron spectra and dose equivalent rates by orthonormal expansion methods. An orthonormal set of functions is obtained by selecting base functions and a density function to be orthonormalized by the Schmidt method or by preparing conventional orthogonal functions (Fourier, Bessel function, and Laguerre polynomials) in the subroutine. This code can be used for the analysis of spectra and dose equivalent rates not only of neutrons but also of photons, and further applied to such an analogous problem as calculation of the spatial distribution of radioactive substance. The time spent in calculation is about one minute in the case where ten detectors and thirty-three energy mesh points are treated. (auth)

43228 (ORNL-TM–1127(Rev.1)) DESCRIPTION OF FACILITY RADIATION AND CONTAMINATION SYSTEMS INSTALLED IN THE MOLTEN-SALT REACTOR EXPERIMENT, BLDG. 7503. Russell, J. A. Jr.; Knowles, D. J. (Oak Ridge National Lab., Tenn.). Aug. 22, 1967. Contract W-7405-eng-26. 23p. Dep. CFSTI.

The Facility Radiation and Contamination Systems installed in the Molten-Salt Reactor Experiment Building 7503 continuously and automatically monitor gamma radiation (by seven gamma monitrons) and air contamination (by seven beta-gamma air monitors) in the entire facility. These instruments and other components in the network provide health physics monitoring information, sound local alarms when abnormal conditions occur, and indicate the abnormal conditions on a central panel board. The building evacuation system operates automatically when two or more monitrons or two or more air monitors detect a high level of radiation or air contamination. Operating experience with this system is briefly discussed. (auth)

43229 (ORNL-TM–1836) A FORTRAN IV/63 PROGRAM PACKAGE FOR CALCULATING THE TIME CHANNEL RESPONSE FUNCTION IN NEUTRON TIME-OF-FLIGHT SPECTROSCOPY. Santoro, R. T. (Oak Ridge National Lab., Tenn.). Aug. 18, 1967. Contract W-7405-eng-26. 109p. Dep. CFSTI.

Three computer programs — PTIME, TWALK, and CONVOL —

for computing the time-channel response function for a neutron time-of-flight spectrometer are described. PTIME computes the time-jitter smeared physical flight-time distribution for the target detector configuration where the incident beam and the detected neutrons are along the cylindrical axes of the target and detector, respectively. The flight-time resolution and spectrometer efficiency are computed and plotted results are provided. TWALK computes the neutron pulse-height spectrum and generates the time-slewing response function with the aid of the time-slewing curve. CONVOL performs the integral over the time-analyzer response function of the convolution of the physical flight-time distribution and the time-slewing response function. Instructions on the use of these codes with the CDC-1604 computer are described along with input card formats required for execution. The methods of entabulation and interpolation of graphic data are included. Complete program listings are presented in appendices. (auth)

43230 (ORNL-TM-1879) FLEXI-KLUDGE: A MULTI-PARAMETER NUCLEAR SPECTRUM SUMMING SYSTEM FOR THE PDP-8. Rust, B. W.; Burrus, W. R. (Oak Ridge National Lab., Tenn.). Aug. 18, 1967. Contract W-7405-eng-26. 69p. Dep. CFSTI.

FLEXI-KLUDGE, a system of PDP-8 programs for the on-line accumulation and summing of multi-parameter nuclear spectra, is described. Pulse heights from four different detectors are brought into the computer together with flags which contain coincidence, pulser, and pile-up information. Upon initialization, the operator may impose conditions for the accumulation or summing of any of the four spectra. The result is a single dimensional 2048 channel pulse height distribution. A word and a half (18 bits) are used for the count storage for each channel. Routines are provided for typing out and integrating the spectrum between limits specified by the user and for displaying the spectrum on the oscilloscope. Routines are also provided for driving a Moseley X-Y plotter which is connected in parallel with the scope. The full 2048 channels are plotted on two 11 by 14 inch graphs in the form of an inked histogram in less than a minute. The primary purpose of the FLEXI-KLUDGE system is to aid in the routine testing and setting up of multi-parameter experiments. (auth)

43231 (STI/PUB-136) NEUTRON MONITORING. Proceedings of the Symposium on Neutron Monitoring for Radiological Protection Held in Vienna, 29 August–2 September 1966. Proceedings Series. (International Atomic Energy Agency, Vienna (Austria)). Jan. 1967. 716p. (In several languages). (CONF-660807). IAEA: $14.50; Austrian Schillings 375,-; £5.2.4; F Fr 71,10; DM 58,-.

Separate abstracts were prepared for 21 of the 57 papers presented. Thirty-six papers were previously included in NSA. For abstract numbers of these papers see CONF-660807 in the report number index. (B.G.D.)

For abstracts of individual papers see: 43237–43241, 43279–43292, 43388, and 43389.

43232 A FLOW MONITORING GEIGER COUNTER FOR RADIOACTIVITY ASSAY OF ORGANIC COMPOUNDS LABELLED WITH ^{14}C. Barakat, M. F. (Atomic Energy Establishment, Cairo). Indian J. Chem., 5: 200-2(May 1967).

A simple and cheap counting system for the almost absolute and rapid radioactivity assay of ^{14}C-labeled organic compounds is described. Good counter design and successful construction are indicated by the long flat counter plateau curves and low background values. An additional feature is that the changes in the rate of flow of the argon–butane counter gas mixture have no adverse effects on the height, position length of the counter plateau and that the position of the counter plateau is affected only by the composition of the counter gas mixture. It is also possible to obtain comparable data while working on compounds with different chemical forms. (auth)

43233 EXPERIMENTAL STUDY OF ELECTRON–PHOTON CASCADES IN A LEAD–SCINTILLATOR ARRANGEMENT FOR PRIMARY ENERGIES BETWEEN 100 AND 440 MeV. Beuermann, Klaus-Peter; Wibberenz, Gerd (Christian-Albrechts-Univ., Kiel). Z. Phys., 206: 247-65(1967). (In German).

Showers generated by electrons of 200- and 440-MeV energy in single lead plates of 2, 5, and 10 radiation lengths are measured in scintillator material (NE 102 A) varying between 1.24 and 10.5 g/cm^2. The mean energy deposited in a scintillator is derived from Nagel's Monte Carlo calculations. The photon contribution n_γ to the total pulse height is of the order 15% near shower maximum t_{max}; it dominates the electron contribution n_e in a 3 cm thick scintillator for shower depths $t \geq 4.2 \cdot t_{max}$. The slope of the total ionization $n_e + n_\gamma$ behind the shower maximum can be approximated by $n(t) \sim \exp(-0.264\ t)$. The shower absorption in scintillator depends on the thickness x (g/cm^2) as $\exp(-0.068\ x)$. An arrangement of counter trays, scintillators and lead plates is calibrated with electrons between 100 and 440 MeV. A suitably defined track-length S is shown to give minimum error in energy measurement and to depend linearly on electron energy. The track-length constant of 22 MeV/r.l. is compared with the results of other authors. (auth)

43234 REDUCTION OF THE TIME OF RESOLUTION IN FAST-COINCIDENCE CIRCUITS, USING SLOW SCINTILLATORS. Patrutescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz., 19: 561-89(1967). (In Rumanian).

In many nuclear-physics experiments, such as (n,γ) reactions, angular correlation measurements, determination of the life times of excited states, etc., the energy distribution and the time sequence must be simultaneously determined. Most of the detection systems satisfy only one of these requirements. In view of the importance of this problem, the currently used methods for the design of coincidence circuits with a time resolution in the nanosecond range by means of slow scintillators, are surveyed. Reduction of the time of resolution by means of coincidence circuits requires a minimum dependence on the position of the impulse on the time axis on the time dispersions arising at the input. The methods examined included those based on a very low input threshold, saturated amplifiers, oscillating circuits, effects of the amplitude and duration of the input pulses, coincidence measurements by difference, etc. (Review article, 59 references). (TTT)

43235 NEUTRON DETECTION PROBABILITY OF A DIGITIZED GAS-DISCHARGE DETECTOR. Epple, E.; Decker, D.; Hornung, F. (Technische Hochschule, Stuttgart). Phys. Lett., 25A: 391-3(Sept. 11, 1967).

The neutron detection probability and gamma discrimination of a digitized gas-discharge detector with crossed electrodes is described. It permits one to localize the passage of a particle. The detection process results not from sparks but from discharges in the proportional and in the restricted proportional region. (auth)

43236 USE OF A GERMANIUM–γ SPECTROMETER FOR INVESTIGATING SOME REACTOR PARAMETERS. Bushuev, A. V.; Dvoretskii, V. N.; Demidov, A. M.; Yurova, L. N. At. Energ. (USSR), 22: 510-12(June 1967). (In Russian).

Semiconductor detectors with up to 4-mm thick, lithium drifted p-type germanium layer, were used for γ spectrometric studies. Germanium spectrometers are quite efficient for measuring soft γ radiations and possess a higher resolution than the scintillation instruments. They may be used for studying the hard portion of the spectra because their high energy resolution compensates for the reduced efficiency. Use of this type of instrument makes it possible to determine fuel burnup on the basis of the intensity of the 662-keV ^{137}Cs line; it also allows to study neutron spectra, to determine the diffusion of gaseous fission products within fuel elements, to measure the fast neutron multiplication factor from the relative intensity of 1.6-MeV and 741-keV lines of ^{140}La and ^{99}Mo, respectively, in the fission fragment spectra of ^{235}U and ^{238}U. The burnup may be also estimated from the buildup of ^{137}Cs, without knowing the past history of the fuel element. (TTT)

43237 DIFFERENTIAL RECOMBINATION CHAMBER. Zel'chinskii, M.; Zharnovetskii, K. (Inst. for Nuclear Research, Sverk, Poland). pp 125-33 of STI/PUB-136. (In Russian).

The recombination chambers previously described by the authors, i.e., ionization chambers providing conditions for columnar recombination of ions, are principally used to determine the quality factor (QF) of mixed penetrating radiation. A measure of the QF is the efficiency of ion collection in the chamber at a given voltage of the electric field. A modification to the recombination chamber making it suitable for direct measurement of the dose-equivalent (DE) is described. For this purpose, the measuring electrode or system of electrodes divides the operating volume of the chamber into two parts with a fixed ratio between the mass of gas contained between the measuring electrode and the input electrodes on either side. The voltage of the electric field or the gas pressure differ on either side of the measuring electrode, and are so selected that the efficiency of ion collection in one of the parts, as a result of the columnar recombination occurring in the gas, changes linearly with QF. The other part operates in conditions close to saturation. The directions of the electric field in relation to the measuring electrode are opposite in the two parts of the chamber. Thus, the measuring current is the difference in the charges collected per unit of time from the operating volumes of the chamber. In view of the differences in ion collection efficiency, this differential current is proportional to QF. The proportionality of the current to absorbed dose-rate is also obvious. As a result, the current measured is proportional to the product of dose-rate and QF, i.e., to the DE rate. The differential recombination chamber can be used

for continuous recording of the degree of radiation hazard from mixed penetrating radiation of any composition and spectrum which changes quantitatively and qualitatively with time. A further advantage of the differential chamber over the normal recombination chamber is the reduced need for stability of the electrometer. Thus it can be used with a conventional small electrometer as a portable instrument for dosimetric control. One of the first models of such a differential recombination chamber was constructed. It can be used both for dosimetric control measurements and for laboratory investigations. The chamber contains 25 flat electrodes made of a tissue-equivalent material. The distance between the electrodes is fixed by spacers. Appropriate connection of the external leads of the electrodes permits the instrument to be used both as a differential chamber and as a double differential-saturated chamber, mainly for determining the QF of radiation. From the data obtained in investigations of ion recombination characteristics in gases, optimum values can be chosen for the distances between the electrodes, the pressure and the composition of the gas mixture, depending on the use to which the chamber is to be put. (auth)

43238 STILBENE SCINTILLATION COUNTER WITH PULSE-SHAPE DISCRIMINATION AGAINST GAMMA RADIATION FOR MEASUREMENT OF FAST-NEUTRON SPECTRA AND DOSE. Gredel, H.; Saebel, M. (Gesellschaft fuer Strahlenforschung m.b.H., Munich). pp 167-77 of STI/PUB-136.

A scintillation counter with a stilbene crystal was constructed for measurement of fast-neutron spectra and dose in the energy range from 1 to 10 MeV. The instrument operates independently of the incident angle of the neutrons. The neutron spectrum is calculated from the energy distribution of the recoil protons produced by the neutrons in the scintillator. Insensitivity to γ radiation is achieved by pulse-shape discrimination. In a circuit at the anode of the photomultiplier the fast component of the scintillation pulse is separated from the total charge pulse. By comparing the pulse heights of the fast-component pulse with the total-charge pulse a gating pulse is obtained when the incident particle is a neutron. This pulse is used for gating a multichannel analyser and a dose-rate meter. Subsequently, a fast-neutron dose-rate meter was constructed which can measure a neutron dose rate of a few μrads/h in the presence of a γ-radiation up to 1 mrad/h. This instrument consists essentially of a nonlinear amplifier, a linear gate and an integrating circuit. (auth)

43239 EXPERIMENTAL STUDY OF THE ENERGY CHARACTERISTICS OF A SLOW NEUTRON DETECTOR WITH SPHERICAL MODERATORS. Keirim-Markus, I. B.; Uspenskii, L. N. (Inst. of Biophysics, Moscow). pp 269-77 of STI/PUB-136. (In Russian).

The efficiency, as a function of moderator diameter, of a slow-neutron scintillation counter with spherical polyethylene moderators having diameters of 100-320 mm and with spherical cadmium shields located at various depths within the moderators was investigated. The investigations were carried out with a Van de Graaff accelerator and a fast pulsed (IBR) reactor in the neutron energy range 5 eV-17 MeV. The results are compared with calculation and with the results of other authors. On the basis of the relationships obtained, the optimal moderator dimensions for a slow-neutron scintillation counter, which will enable one to measure the dose-equivalent rate and neutron flux density over a wide range were recommended. (auth)

43240 SHORT BF_3 COUNTERS AND THEIR USE WITH SPHERICAL MODERATORS: PHYSICAL CHARACTERISTICS AND CHOICE OF USEFUL THICKNESSES OF THE MODERATOR. de Kerviler, H.; Tardy-Joubert, Ph. (CEA, Saclay, France). pp 279-88 of STI/PUB-136. (In French).

The anisotropy of standard BF_3 counters placed in cylindrical moderators is considerable, and in scattered neutron fluxes may lead to measurement errors of as much as a factor of 2. To eliminate this defect, a short BF_3 counter was designed having both satisfactory sensitivity and a small useful volume. The exact dimensions of this volume were determined by studying the collection regions (through analysis of the electric field present in the counter). These counters are placed in paraffin spheres whose useful thickness varies according to whether fluence or dose-equivalent measurements are to be made. The paper describes the limits of the method and discusses the overall accuracy of measurement for a number of spectra commonly obtained at the installations, to clarify the terms in which the results are interpreted. The attractiveness of these counters, compared with lithium-iodide scintillators, for measuring neutrons in the presence of gamma radiation is illustrated by an assessment of the maximum electron-energy loss in the two instruments. (auth)

43241 MEASUREMENTS OF NEUTRON FLUX BY ACTIVATION FOR CALIBRATING A FILM BADGE. Busuoli, G.; Cavallini, A.; Fasso, A.; Rimondi, O. (CNEN, Bologna). pp 525-36 of STI/PUB-136. (In Italian).

As the first step in the design of a film badge for thermal and epithermal neutrons, fluxes of different composition, obtained from a radioactive source immersed in water were calibrated. The neutron fluxes were evaluated on the basis of the activation of gold foils irradiated both with and without cladding so that the thermal and epithermal components could be distinguished. The measurements of the activity of the gold fish, made with a low-background gas-flow counter, were corrected by taking into account the effects of flux depression, self-shielding, self-absorption and backscattering. After ascertaining the flux value, they began measurements to determine the effects due to activation of the Ag-Br contained in the Kodak photographic (radiation monitoring) emulsion. It is intended to compare the results obtained with the theoretical calculation. The final purpose of the study is to devise a system of shields for insertion in the badges to make the film response proportional to the dose due to either component of the neutron flux. (auth)

43242 SOME CHARACTERISTICS OF LITHIUM-DRIFTED SILICON STRUCTURES. Baily, N. A.; Akutagawa, W. M.; Andres, R. J., Montano, H. L. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 38: 3907-12(Sept. 1967).

Collection efficiency for carriers generated by visible light and potential path distributions were studied in p–i–n structures formed from p-type silicon after compensation by the lithium drift method. The experimental results show that the characteristics of the resultant devices are similar to those expected when an excess donor concentration exists in the compensated region. The effects of high-field, reverse-bias, room-temperature storage indicate that a reduction in the donor concentration takes place under these conditions, resulting in a device behaving more like a p–i–n structure. (auth)

43243 DESIGN AND PERFORMANCE OF A K^+ DETECTOR. Giacomelli, G.; Kycia, T. F.; Li, K. K.; Teiger, J. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Rev. Sci. Instrum., 38: 1408-11(Oct. 1967). (BNL-11056).

The design, construction, and performance of a 320-liter cylindrical stopping K^+ detector is described. The efficiency of the detector is measured to be about 70%. (auth)

43244 PROGRAM TO SMOOTH THE NOISE OF EXPERIMENTAL WAVEFORMS. De Lotto, I.; Osnaghi, S. (Facolta di Ingegneria, Bologna). Nucl. Instrum. Methods, 54: 305-7(Oct. 1967).

A method is presented to smooth a noisy waveform by introducing a correlation between adjacent channels dependent of the channel number. (auth)

43245 SIMPLE LIGHT SPOT SCANNER AND ITS APPLICATION ON SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. Schuler, Werner (ORTEC Inc., Oak Ridge, Tenn.). Rev. Sci. Instrum., 38: 1374-6(Oct. 1967).

An apparatus has been designed and built for scanning the surface of a semiconductor device with a light spot. The apparatus uses a modified commercial television set for the display of the photoresponse and a miniature CRT as flying spot source. Photoresponse pictures of lithium-drifted silicon radiation detectors as well as of surface barrier type detectors are shown and interpretation is attempted. (auth)

43246 CATHODE RAY FILM SCANNER. Carides, T.; Cottingham, J. G.; Feltman, A. V.; Grossman, A. S.; Leipuner, L. B.; Marinuzzi, J. G.; Schwender, G. E. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Rev. Sci. Instrum., 38: 1425-30(Oct. 1967). (BNL-10829).

A spark chamber film reader was developed which uses a computer directed cathode ray spot as the scanning light source. The equipment features data processing speed of 20,000 points per second while achieving position resolution of 4 μ. Search modes and film areas covered are controlled by the computer software giving wide flexibility. (auth)

43247 EFFECT OF BASELINE RESTORATION ON SIGNAL-TO-NOISE RATIO IN PULSE AMPLITUDE MEASUREMENTS. Radeka, Veljko (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instrum., 38: 1397-1403(Oct. 1967). (BNL-11376).

The effect of baseline restoration on signal-to-noise ratio in pulse-amplitude measurements is determined theoretically and experimentally. It is found that the signal-to-noise ratio with baseline restoration normalized to that without restoration is $\eta_r/\eta = [1 + \alpha - 2\alpha^{1/2}k_x(\tau)]^{-1/2}$, where $k_x(\tau)$ is the noise correlation factor at the output of the filter (amplifier), τ is the measurement interval, and α is the attenuation of noise power due to integration by the restorer capacitance and switch resistance ($\alpha = 1$ for fast

restorer). Methods of calculation of correlation functions are outlined. A method for measurement of correlation functions by oscilloscope is described. The results are presented for the three commonly used filters: CR-RC filter, quasi-Gaussian filter, and delay-line filter. Baseline restoration is found to degrade the signal-to-noise ratio. The amount of this degradation can be reduced to negligible proportions in filters with long memory (such as CR-RC) by a small degree of integration in the restorer. Peak-to-peak amplitude measurement of double-differentiated signals performs, in effect, baseline restoration and, in addition, improves signal-to-noise ratio compared to peak-amplitude measurement. (auth)

43248 PROPORTIONAL COUNTERS AND ELECTRONIC SYSTEMS FOR OBSERVING COSMIC X RAYS. Chodil, G.; Mark, Hans; Rodrigues, R. M.; Rowe, C.; Swift, C. D. (Univ. of California, Livermore). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 1508-14(Oct. 1967). (UCRL-70359).

A low-energy x-ray detection system was developed and used on two sounding rocket flights. Proportional counters, sensitive to x rays with quantum energies between 2 and 30 keV, are used in this system. The signals from these counters are modified so that they can be telemetered with an FM-FM system in such a way that the pulse amplitude is preserved. Pulse-height analysis is done at the ground station. With this simple system, it is possible to obtain spectra of cosmic x-ray sources limited only by the resolution of the detectors. (auth)

43249 DETECTION EFFICIENCY OF A CONTINUOUS CHANNEL ELECTRON MULTIPLIER FOR POSITIVE IONS. Burrous, Clifford N.; Lieber, Albert J.; Zaviantseff, Vladimir T. (Ames Research Center, Moffett Field, Calif.). Rev. Sci. Instrum., 38: 1477-81(Oct. 1967).

The relative detection efficiency of a curved continuous channel electron multiplier has been measured for H^+, H_2^+, $^3He^+$, $^3He^{2+}$, He^+, Ne^+, and Ar^+ ions over a 500-eV to 18-keV energy range. The detector's efficiency is presented as a function of the incoming ion's energy, velocity, and degree of ionization. Preacceleration was employed to reduce the falloff in efficiency for energies below 3 keV. (auth)

43250 REGULATED dc-dc CONVERTER PROVIDES LOW STANDBY CURRENT FOR PORTABLE RADIATION SURVEY INSTRUMENTS. Lakin, R. W. (Univ. of California, Livermore). Contract W-7405-eng-48. Rev. Sci. Instrum., 38: 1526-7(Oct. 1967). (UCRL-70456).

A regulated high-voltage power supply, which incorporates a series-regulating transistor and a field-effect transistor error sensing circuit was developed for use with a portable radiation survey instrument employing a Geiger-Mueller detector. (B.G.D.)

43251 ELECTRONIC CIRCUITS USED IN A SEMICONDUCTOR DETECTOR ALPHA SPECTROMETER FOR COINCIDENCE MEASUREMENTS. Klein, S. S.; Hulstman, L.; Blok, J. (Vrije Univ., Amsterdam). Nucl. Instrum. Methods, 54: 190-8(Oct. 1967).

An alpha spectrometer was developed for the purpose of coincidence measurements at high counting rates while retaining high resolution and stability. The alpha resolution, measured using a Th(B + C) source, varies from 19 keV at counting rates below 2000 cps to 27 keV at 7400 cps; indications are given how this upper limit may be improved. The stability is about 0.2 keV/h or 2 keV/day; a significant part of this is caused by temperature effects in the detector. It will be very difficult to attain better stability with semiconductor detectors unless ambient temperature is stabilized. Consideration is given to the use of field effect transistors (FETs) in the input stage and transistors in the remainder of the amplifying circuits. It is concluded that the resolution may be improved only by using cooled FETs. (auth)

43252 ION-OPTICS OF A SPLIT POLE MAGNETIC SPECTROGRAPH. Viswesvariah, M. N.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). Nucl. Instrum. Methods, 54: 181-9(Oct. 1967).

The ion-optics of a split-pole magnetic spectrograph were investigated theoretically. Expressions are given for the final image distance, median plane and vertical magnifications, dispersion, and momentum resolution. The effect of Doppler broadening due to the nuclear reaction kinematics was also taken into account. The equations were programmed on a CDC 3600 computer and results obtained for a given pole-face layout. (auth)

43253 THERMAL NEUTRON CAPTURE GAMMAS MEASURED WITH Ge(Li)-SPECTROMETERS AND INTERNAL REACTOR TARGETS. Arnell, S. E.; Hardell, R.; Hasselgren, A.; Jonsson, L.; Skeppstedt, O. (Univ. of Tech., Goteborg). Nucl. Instrum. Methods, 54: 165-80(Oct. 1967).

An experimental arrangement for the study of thermal neutron capture gammas from reactions with low cross sections or where use is made of small amounts of separated isotopes is described. In this arrangement a through evacuated reactor channel and Ge(Li)-spectrometers for gamma detection are used. For the measurement of capture gammas above the pair production threshold a three crystal pair spectrometer employing a Ge(Li)-crystal surrounded by a bisected NaI-annulus is used. For the measurement of the low energy part of (n,γ)-spectra the same annulus is used in the anticoincidence mode. The efficiency of the anticoincidence mantle for detecting backscattered quanta from the Ge(Li)-crystal is increased by adding a 5" dia × 4" long NaI-crystal with a through axial hole to the anticoincidence assembly. The functioning of the spectrometers is illustrated with capture gammas from the Ar(n,γ)- and $^{54}Fe(n,\gamma)$-reactions. The efficiency of the spectrometers and the background conditions are discussed and related to the minimum target quantities required. (auth)

43254 FILMLESS SPARK CHAMBER SYSTEM FOR OPERATION WITH ON-LINE COMPUTER. Chuvilo, I. V.; Filipov, P. I.; Gavrilov, A. S.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 54: 217-22(Oct. 1967).

A system of nine wire spark chambers having magnetostrictive readout, data acquisition electronics used on-line with the computer BESM-3M located at a 1 km distance from the experimental area was designed and tested using a negative pion beam of the Dubna synchrophasotron. (auth)

43255 VIDICON SYSTEM FOR THE AUTOMATIC RECORDING OF SPARK CHAMBER EVENTS. Jarlskog, G.; Kivikas, T. (Univ. of Lund, Sweden). Nucl. Instrum. Methods, 54: 282-7 (Oct. 1967).

A vidicon system adapted for magnetic tape recording or on-line data processing was developed. It has an error in locating a spark position of less than 1‰ and a two-spark resolution that is better than 1%. (auth)

43256 ALPHA-PROTON DISCRIMINATION WITH A NE 213 LIQUID SCINTILLATOR USED FOR THE MEASUREMENT OF THE (n,α)-REACTION ON ^{12}C. Kopsch, D.; Cierjacks, S. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 54: 277-81(Oct. 1967).

With a NE 213 liquid scintillator a discrimination between alpha particles and protons (down to a lower limit of $E\alpha = 5.8$ MeV) was accomplished. The differences in the response for protons and α-particles in this scintillator allowed the measurement of the energy spectra for these particles by means of a two-dimensional analysis. As an application of particle separation, fast neutron interactions with the carbon atoms of the scintillator were studied. A cross-section for the (n,α) reaction on ^{12}C leading to α-particle energies higher than 5.8 MeV of 72.7 ± 6.8 mb at $E_n = 14.1$ MeV was determined. (auth)

43257 A SINGLE CRYSTAL Ge(Li) COMPTON SPECTROMETER. Gruhn, C. R.; Kane, J. V.; Kelly, W. H.; Kuo, T.; Berzins, G. (Michigan State Univ., East Lansing). Nucl. Instrum. Methods, 54: 268-76(Oct. 1967).

A single crystal Ge(Li) Compton spectrometer was tested showing considerable promise as a device for detecting γ rays in the presence of strong Compton and neutron backgrounds. (auth)

43258 READOUT AND MONITOR SYSTEM FOR A MULTIWIRE SPARK CHAMBER BY MAGNETOSTRICTIVE DELAY LINE. Miyamoto, S.; Hara, T.; Tsuji, K. (Osaka City Univ.). Nucl. Instrum. Methods, 54: 253-60(Oct. 1967).

The magnetostrictive delay line method is applied to reading out the data of a large multiwire spark chamber, and a paper puncher is used as a recording device. The details of this system are described. The monitoring system of this chamber is found to be very useful not only for monitoring the performance of the spark chamber, but also for the adjustment of the circuits. The accuracy of the determination of particle tracks by this chamber is about 1.3 mm, and the resolution of two tracks is about 1 cm. (auth)

43259 REJECTION OF MUON STOPS IN TELESCOPE COUNTERS. Sundelin, R. M.; Takahashi, K. (Carnegie Inst. of Tech., Pittsburgh). Nucl. Instrum. Methods, 54: 250-2(Oct. 1967).

Background arising from muons stopping in the last beam telescope counter before the target is a common problem in experiments in which muons are to be stopped in a target. A technique involving the pulse heights in the last two telescope counters before the target was devised to permit the rejection of muon stops in the telescope counters. By relinquishing the 0.1 g/cm² target layer nearest the last telescope counter, approximately 99% of the muons stopping in the last telescope counter can be rejected. (auth)

43260 SEMICONDUCTOR RADIATION DETECTORS USED WITH CURRENT-SENSITIVE PREAMPLIFIERS. Poenaru, D. N. (Inst. for Atomic Physics, Bucharest). Nucl. Instrum. Methods, 54: 242-9(Oct. 1967).

The utilization of short current pulses given by L- and U-type semiconductor radiation detectors was investigated. The maximum amplitude and minimum length of the current pulses from silicon detectors were calculated and plotted against resistivity for L detectors and voltage for U detectors respectively. By using a low input impedance, fast transistor current-sensitive preamplifier, L-detector exponential current waveforms (for 4 MeV protons, 5–15 MeV alpha particles and fission fragments) were verified. The possibility to employ current pulses for heavy charged particle spectrometry and to obtain simultaneously fast and slow pulses from the same detector were also checked experimentally. (auth)

43261 CURRENT AND VOLTAGE PULSES GIVEN BY SEMICONDUCTOR RADIATION DETECTORS. Poenaru, D. N. (Inst. for Atomic Physics, Bucharest). Nucl. Instrum. Methods, 54: 229-41(Oct. 1967).

Voltage and current waveforms given by different types of semiconductor detectors on various load impedances were calculated. The response of the SD equivalent circuit and its Laplace transform with zero- and pole-locations was tabulated for the four practical cases: voltage-, charge sensitive-, current-, as well as charge senstive–and current preamplifiers. A unitary specification of detector–preamplifier ensemble was suggested. The calculated voltage and current waveforms were plotted for some particular cases. (auth)

43262 CHANNELING EFFECT IN SOLID STATE DETECTORS. Cipolla, F.; Taroni, A. (Univ., Bologna). Nucl. Instrum. Methods, 54: 331-2(Oct. 1967).

A channeling effect was observed in silicon detectors with α particles. The α particles are sent on the back side of a dE/dx detector biased at a voltage such that the space charge width is about 50 μm shorter than the detector thickness; in this manner the nonchanneled particles are stopped in the undepleted region while the channeled particles reach the space charge region; the spectrum obtained with a multichannel analyzer shows a two peaks structure. (auth)

43263 TIME RESOLVING POWER OF THE MULTIWIRE SPARK COUNTER. Marinescu, L.; Petrascu, M.; Voiculescu, G. (Inst. of Atomic Physics, Bucharest). Nucl. Instrum. Methods, 54: 327-8(Oct. 1967).

The time resolving power of the multiwire spark counter was measured. It was found a standard fluctuation of about 150 nsec of the delay between the passage of an ionizing particle and the appearance of the spark. (auth)

43264 SCINTILLATION PROBE FOR CONTINUOUS MONITORING OF TRITIATED WATER. Muramatsu, M.; Koyano, A.; Tokunaga, N. (Tokyo Metropolitan Univ. Japan Radiation and Medical Electronics, Inc., Tokyo). Nucl. Instrum. Methods, 54: 325-6(Oct. 1967).

Continuous monitoring of tritiated water was achieved conveniently by dipping into the sample water a scintillator probe wherein a scintillator sheet having serrated surface is attached to a surface of prismatic light guide for dividing and transmitting the optical scintillae into two phototubes leading to the coincidence circuit. (auth)

43265 AN X–Y POSITION SENSITIVE DETECTOR. Kalbitzer, S.; Bader, R.; Melzer, W.; Stumpfl, W. (Max Planck Institut fuer Kernphysik, Heidelberg). Nucl. Instrum. Methods, 54: 323-4(Oct. 1967).

By implantation of boron resp. phosphorus ions into n-type silicon p^+-n-n^+ junction detectors were produced. The p^+ and n^+ resistive layers served to provide X and Y information of the position of incidence of ionizing particles. (auth)

43266 CALCULATION OF SOLID ANGLE BETWEEN SOURCE AND DETECTOR. Bonnet, C.; Hillion, P.; Nurdin, G. Nucl. Instrum. Methods, 54: 321-2(Oct. 1967). (In French).

A Monte Carlo calculation of source to detector geometry which gives a better variance than a preceding one described by Williams. Source and detector are circular and located on two parallel planes. (auth)

43267 TRIGGERED SPARK GAP FOR DISCHARGING SPARK CHAMBERS. Rey, C. A.; Parker, S. I. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 54: 314-16(Oct. 1967). (UCRL-17598).

A compact, simple, internally triggered spark gap for discharging spark chambers is described. The pulse on the spark chamber provides the trigger spark by charging a capacitor formed by the trigger electrode, one of the two main electrodes, and an alumina dielectric until a surface breakdown occurs across the dielectric. The unit provides delay times of 15 to 100 nsec with jitter times of several nsec and has a life of the order of a million pulses when discharging 20,000 pF from 10 kV. (auth)

43268 AUTOMATIZED DIRECTIONAL CORRELATION ARRANGEMENT. Lourens, W.; Van Baren, P. M. H. (Laboratorium voor Technische Physica, Delft, Netherlands). Nucl. Instrum. Methods, 54: 311-13(Oct. 1967).

The mechanical and electronic construction of an automatically running arrangement for the measurement of directional correlations are described. (auth)

43269 HIGH ENERGY GAMMA RAY ENERGY MEASUREMENTS. McDaniels, D. K.; Dolan, K. W.; Piluso, C. J. (Univ. of Oregon, Eugene). Contract AT(45-1)-1925. Nucl. Instrum. Methods, 54: 317-20(Oct. 1967). (RLO–1925-07).

An easy method to measure gamma ray energies to about 0.003 MeV is suggested which utilizes the reaction Q-value, and demands consistency between the sum of the cascade gamma ray energies between two levels and the energy of the direct transition. This procedure is applied to the 0.9363-MeV resonance in the $^{27}Al(p,\gamma)^{28}Si$ reaction. (auth)

43270 A RAPID CYCLING THREE-STAGE VALVE FOR THE 2M LIQUID HYDROGEN BUBBLE CHAMBER. Gerber, G. B.; Shkarlet, V. D. Cryogenics, 7: 175-6(June 1967).

A pneumatic valve is described capable of effecting pressure changes of up to 60 atmospheres in a time of ~2 msec. A piston stroke of five cm is achieved in ~4 msec. The valve is designed to switch between two 5 liter volumes, and has an orifice of 70 mm. (UK)

43271 PROBLEMS OF CHEMOLUMINESCENCE IN LIQUID SCINTILLATION COUNTING USING THE HYDROXIDE OF HYAMINE 10-X. Kalbhen, D. A. (Univ., Bonn). Int. J. Appl. Radiat. Isotop., 18: 655-6(Sept. 1967).

The hydroxide of p-(di-isobutyl-cresoxyethoxyethyl)-dimethylbenzylammonium chloride monohydrate (Hyamine 10-X) is widely used in liquid scintillation counting as a solubilizing agent for various biological materials such as proteins, polysaccharides, entire tissues, etc. There is, however, a danger of interference with the counting material because of an intensive and persistent chemoluminescence produced by hyamine. A few quantitative results obtained in the study of chemoluminescence of liquid scintillation mixtures used in biological assays are presented. (auth) (UK)

43272 INSTANTANEOUS PLOTTING OF SCINTILLATION SPECTROMETER OUTPUT. Brunk, C.; Hanawalt, P. C. (Stanford Univ., Calif.). Int. J. Appl. Radiat. Isotop., 18: 721-3(Oct. 1967).

The use of radioactive tracers in biochemical studies often gives rise to sequence of samples to be assayed. In such applications of radioactive tracer methods it would be extremely convenient to have a rapid and simple graphical display of the counting rate as a function of sample number. Several methods for automatically obtaining graphical plots of counting rates are available, but they usually involve some type of intermediate storage stage in data transmission, such as punched tapes or cards, and the computer-directed plotting of these punched data. Unless the information is to be catalogued and subsequently handled in a variety of ways it is too expensive and time consuming to use computer methods for each sequence of raw data samples. The alternative system described immediately translates counting rates into a histogram, and is extremely useful for a variety of applications. The automatic count rate plotting system consists simply of a rate meter and chart recorder used in conjunction with a scintillation spectrometer. (auth) (UK)

43273 SEMICONDUCTOR DETECTOR CRYOSTAT (Engineering Materials). (California Univ., Berkeley. Lawrence Radiation Lab.). (CAPE-1643).

66 drawings.

A multipurpose standardized cryostat system used with nonencapsulated Ge(Li) and Si(Li) semiconductor radiation detectors is described. Welding and vacuum-furnace brazing fabrication techniques are used to provide high-integrity joints and eliminate possible sources of solder flux, chemicals and solvent contamination. Vacuum in the cryostat is maintained at 3×10^{-7} torr by a sputter-ion pump and gravity-feed liquid nitrogen cooling is employed. End cap removal permits access for installation and removal of detectors and wiring. The detector mount, which is electrically isolated, is fabricated of Al and other low-Z materials. (For details see TID-4100 Suppl. 42.) (F.S.)

43274 LIQUID CHERENKOV COUNTER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE–1636).

25 drawings.

A differential Cherenkov counter which employs a liquid solution for a radiator and is used for detecting low momentum particles is described. The velocity band to which the counter is sensitive is controlled by altering the relative position of the optical elements in the counter. The sensitive dia of the counter is 5 in. which is the dia of the radiator. Light detection consists of 2 groups of a high photocathode efficiency-type phototubes which were selected for low noise and even performance. Phototube high voltage is supplied through a medium-current voltage divider chain. A small fan cools the counter and equilibrium temperature is maintained around 40°C. (For details see TID-4100 Suppl. 42.) (F.S.)

43275 FUEL ELEMENT MONITOR (Engineering Materials). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). (CAPE–1649).

16 drawings.

A compact portable gamma spectrometer is described which is used in safeguarding inventories of ^{235}U contained in unirradiated reactor fuel elements. The apparatus can also be used as a general purpose gamma spectrometer. Main chassis solid state circuitry includes a wide-range high voltage supply, double delay line pulse amplifier, split-window gain stabilizer, single channel pulse height analyzer, six decade scaler, automatic timer, count rate meter, low voltage regulators, and a battery charger. Power is supplied by a NiCd rechargeable battery. Electronic circuits except the battery charger are plug-in modules. The main chassis mounts in a transit case. An identical case is provided for the probe, preamplier, collimators and probe stand. (For details see TID-4100 Suppl. 43) (F.S.)

Radiation Dosimeters

Refer also to abstracts 43241 and 43395.

43276 DIGITAL PHOTOMETER FOR FILM BADGE DOSIMETER. Hekrdle, J. Jad. Energ., 11: 452-5(Dec. 1965).

A description of a photometer suitable for medium and large sized workplaces, developed in Czechoslovakia, and a procedure for exposing the emulsion. The apparatus enables film badge dosimetry to be automated in order to keep pace with the increasing number of workers exposed to ionizing radiation. The electrical circuitry is reproduced. The design ensures maximum stability and an accuracy of ±0.01 D with a density range D = 0 – 3. Experiments confirmed the good reproducibility of the measurements, the extent of error being ±0.00025 D within the range D = 0.0 – 1.0; at higher values the error did not exceed ±0.01 D. The apparatus is simple to use, and the results are recorded automatically. At the time of writing, the photometer had already been in service for a year at the Czechoslovak Academy of Science's Nuclear Research Institute and had proved satisfactory. (auth)

43277 PERSONAL DOSIMETRY IN RADIOLOGICAL WORKPLACES. Sedlacek, F. Voj. Zdravot. Listy, 34: 221-6(Oct. 1965).

The results of a systematic check-up of x-radiation doses in the x-ray department of a large hospital, made with film badge and pencil dosimeters, were compared with the records simultaneously made of all treatment given. The pencil dosimeters indicated generally higher readings than did the film badges. The values obtained were for the most part substantially below the maximum permissible doses, especially in the case of laboratory assistants. From the dosimetric standpoint, no relationship could be established between the number of working days and the degree of exposure, nor could any conclusions be drawn from the number of hours worked or procedures carried out. The exposure time in mAh appeared to be the best criterion. The systematic dosimetric supervision resulted in a decrease in the doses received by both physicians and laboratory assistants (down by 50% in the case of irrigoradioscopy and by 80% in that of perimyelography). (auth)

43278 THERMOLUMINESCENCE FAST NEUTRON DOSIMETER. Kuz'min, V. V.; Lushchik, Ch. B.; Savikhin, F. A.; Sokolov, A. D.; Yaek, I. V. At. Energ. (USSR), 22: 482-8(June 1967). (In Russian).

The requirements on the values of conversion efficiency of thermoluminescent phosphors for their utilization in personal dosimetry of fast neutrons, established in the basis of the utilization of the effect of the registration of proton emission, were determined. It was shown that the problem can be solved by the use of luminescent phosphors with nonlinear dependence of the luminescent yield on the volume density of the excitation. A method for the production of luminescent phosphors with the required parameters, their characteristics during recording of light and heavy charged particles, and the parameters of the dosimeter with such luminescent phosphors were described. The results of tests of the dosimeter showed that its motion with rigidity for neutrons is ±20% in the neutron energy range from 0.3 to 10 MeV. The sensitivity of the dosimeter, expressed in equal-valent dose exposures for fast neutrons is at least two times higher than for γ radiation. The lower limit for the registration of the neutron dose is 5 mRem. (tr-auth)

43279 AN EXPERIMENTAL APPRAISAL OF THE VALIDITY OF NEUTRON DOSIMETRY THEORY IN RADIATION PROTECTION. Watt, D. E.; Lawson, R. C.; Clare, D. M. (United Kingdom Atomic Energy Authority, Chapelcross, Eng.). pp 27-40 of STI/PUB–136.

It is shown how a detector made from a thin layer of plastic scintillator arranged to conform with the Bragg-Gray principle can be used to determine accurate values of absorbed dose, quality factors, and LET distributions for proton recoils at depth in tissue for incident Pu-Be, D, D and D, T neutrons. The $^{14}N(n,p)^{14}C$ and $^{1}H(n,\gamma)^{2}H$ dose distributions are deducted from thermal-neutron flux measurements. Experimental results are presented and compared with the theories of Snyder and Neufeld, Randolph and Boag. (auth)

43280 CRITICAL REFLECTIONS ON NEUTRON DOSIMETRY. Ladu, M.; Pelliccioni, M. (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). pp 99-108 of STI/PUB–136. (In Italian).

Neutron dosimetry is unsatisfactory at present because the true meaning of the experimental data is not clear. Flux measurements cannot be used to determine the absorbed doses without simultaneous measurement of the spectral distribution of the neutrons, whose QF varies considerably according to the energy. Even with a unit of absorbed dose such as the rad (whose definition is based on physical measuring systems), there is still the problem of how to measure the absorbed energy. Essentially, an instrument for measuring absorbed doses should satisfy at least the following conditions: (1) It should produce no change in the primary flux incident on the subject or should modify it in the same proportions as the subject. (2) It should indicate the absorbed energy accurately. Calorimetric measurements come to mind, but they are insufficiently sensitive (100 rads/min in a substance of unit specific heat produces a temperature rise of 2.5×10^{-4} degC/min). (3) The absorbed energy per unit mass of the dosimeter should be equal or proportional to that absorbed per unit mass of human tissue. Personal dosimetry by means of film badges is inaccurate and insufficiently sensitive. At present, the most reliable dose measurements are those made with tissue-equivalent ionization chambers, but these, too, are unsatisfactory, at least for neutrons of energy between 0.025 eV and 20 keV and above 30 MeV. A method for measuring high-energy neutron doses capable of causing nuclear disintegrations in the body is proposed. (auth)

43281 POSSIBILITY OF USING A LIQUID DIELECTRIC IONIZATION CHAMBER FOR DOSIMETRY OF MIXED RADIATION FIELDS. Ladu, M.; Pelliccioni, M.; Roccella, M. (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy). pp 145-50 of STI/PUB–136. (In Italian).

Findings relating to the behavior of a liquid dielectric ionization chamber in mixed radiation fields are presented. In particular the response of the detector as a function of the quality factor of the radiations used was studied. It is concluded that, in principle, and within the limits of the experience described, a chamber of this type can be used to measure the quality factor of fields of mixed radiations of unknown composition. (auth)

43282 MEASUREMENT OF FAST-NEUTRON DOSE-RATE WITH A SEMICONDUCTOR DETECTOR. Deme, Sh. (Central Research Inst. for Physics, Budapest). pp 235-43 of STI/PUB–136. (In Russian).

Calculations were made to determine under what conditions use can be made of semiconductor detectors to measure fast-neutron tissue doses. It is shown that the Bragg-Gray principle does not hold good here. The structure of the optimal layer of a proton radiator giving the necessary characteristics were calculated. The possibility of using the generalized dosimetry principle of Hurst and Ritchie for a detector with a thick polyethylene radiator is discussed. A computer was used to calculate the amplitude spectra due to protons in semiconductor detectors with different thicknesses of sensitive layer. The type of detector used and the assumed energy dependence of the characteristics of the system are discussed. Measurements were made using a silicon detector of

the surface-barrier type with a thickness of 100 microns. The energy dependence was studied using a source of monoenergetic neutrons in the range 2-5 MeV and the sensitivity to gamma radiation was studied with a ^{60}Co source. Lastly, the possible uses of the system are discussed. (auth)

43283 SILICON FAST-NEUTRON DOSIMETER WITH A WIDE SENSITIVITY RANGE. Thurston, M. O.; Swartz, J. M.; Speers, R. R.; Closser, W. H. (Phylatron Corp., Columbus, Ohio. Ohio State Univ., Columbus). pp 245-52 of STI/PUB-136.

The reduction in the minority carrier lifetime in silicon resulting from fast neutron bombardment can be made the basis of a convenient and accurate dosimeter. The dosimeter structure is a p-i-n diode with an i-region, or base, that is comparable in length to the minority carrier diffusion length. Although the lifetime can be observed directly, a more convenient technique is to measure the forward voltage drop at constant current. The change in forward voltage is nearly linear with respect to neutron dose if the base is conductivity modulated. The sensitivity can be increased by increasing the base thickness provided a sufficiently high lifetime is maintained. The device is capable of immediate nondestructive readout after exposure, and integrates the indication of successive exposures. There is, however, a room-temperature annealing effect that makes the indicated dose after two weeks about 15% less than the immediate reading. The diode reading is independent of the rate of exposure, and nearly independent of the temperature of the diode during exposure (room temperature and below). Its sensitivity decreases with decreasing neutron energy. In the range from 14 to 0.5 MeV the sensitivity is roughly proportional to the cube root of the energy. The device is sufficiently insensitive to thermal neutrons and gamma radiation that it can often be used as a selective fast-neutron dosimeter in mixed fields without special shielding. The system has been calibrated, for a fission spectrum, in the range from <1 to 15,000 rads. (auth)

43284 NEUTRON DOSIMETRY BY THE FISSION-FRAGMENT METHOD. Widell, C.-O. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 417-24 of STI/PUB-136.

Fission fragments, which are heavy particles able to damage a material physically along their paths, are studied. Fissionable material is placed in contact with a material where these damage paths are easily developed and thus used as a neutron dosimeter. A system with uranium in contact with a mica foil is studied. The irradiation procedure and characteristic track dependence on etching time, concentration, and temperature are discussed. The sensitivity of the dosimeter is also studied. (auth)

43285 NEUTRON DOSE MEASUREMENTS BY MEANS OF THE CHERENKOV EFFECT OF INDUCED BETA RADIATION IN GAMMA AND ACTIVATION DOSIMETERS. Piesch, E. (Nuclear Research Centre, Karlsruhe, Ger.). pp 471-93 of STI/PUB-136.

Activation techniques often used in neutron monitoring, namely in criticality accidents, in the measurement of high-energy neutrons and of high-level neutron flux densities are discussed. The beta-activity induced in activation detectors (reactions $^{32}S(n,p)$ ^{32}P and $^{12}C(n,2n)^{11}C$) are detected directly, after concentration or chemical separation of the sample by GM counters, proportional counters, or liquid and plastic scintillators. The Cherenkov radiation measurements of the beta-radionuclide directly in the sample are described for activation detectors using the $^{32}S(n,p)^{32}P$ and $^{31}P(n,p)^{31}Si$ reactions for measuring fast neutrons, as well as for gamma detectors, especially silver-activated metaphosphate glass dosimeters suitable for measuring fast neutrons by the reactions $^{31}P(n,p)^{31}Si$, and thermal neutrons by the ^{32}P-activity. The advantages of these measurement techniques and the possibility of their practical application in personnel and area monitoring are discussed. (auth)

43286 MEASUREMENT OF THE DOSE-EQUIVALENT FROM THERMAL AND INTERMEDIATE-ENERGY NEUTRONS WITH PERSONNEL DOSIMETERS. Dennis, J. A.; Smith, J. W.; Boot, S. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 537-48 of STI/PUB-136.

Factors influencing the readings of personnel neutron dosimeters, particularly the cadmium-covered film and the nuclear-track emulsion types, are discussed. The influences of the intermediate-energy and fast neutrons back-scattered from the body at thermal energies and of the gamma radiation generated in the body by the $^{1}H(n,\gamma)^{2}D$ reaction are considered. It is shown that these phenomena enable reasonably accurate estimations to be made of the dose-equivalent from neutrons with energies in the range thermal to 10 keV and, with certain assumptions about the neutron spectra, also an approximate estimate over the range thermal to 0.3 MeV. (auth)

43287 EDGE EFFECTS IN THE SCANNING OF NUCLEAR-TRACK EMULSIONS FOR NEUTRON DOSE ASSESSMENT. Marshall, T. O.; Stevenson, G. R. (Radiological Protection Service, Belmont, Eng.). pp 549-59 of STI/PUB-136.

The number of recoil-proton tracks observed in a thin nuclear-track emulsion within a radiator-absorber complex is often used as a measure of exposure to fast neutrons, the dose being derived from the number of proton-recoil tracks observed within a given area of the emulsion. To obtain the true track density, only those tracks which originate in or enter into the emulsion from the radiator within the area scanned should be counted: for simplicity in routine scanning, however, all tracks appearing in the scanned area are counted without reference to their point of origin. This simplified technique overestimates the true track density by an amount which depends on the mean projected length of the tracks in the plane of the emulsion together with the size and shape of the scanned area. The percentage over-estimate which results is derived for the three most commonly used scanning techniques, namely: the continuous line scan and the discrete field scan for both square and circular fields. These values are compared with those found experimentally by scanning Kodak personal fast neutron films, type B, that had been exposed, at both normal and grazing incidence, to 14-MeV neutrons and to neutrons from an Am-Be source; good agreement is found. The overestimates ranged from 10% when the line scan technique was used to read films that had been exposed at normal incidence to Am-Be neutrons to 85% when the discrete field method was used with square fields to read films that had been exposed at grazing incidence to 14-MeV neutrons. The implications of these results on the basic energy-response data and the method of routine calibration for fast neutron films is discussed. Finally, a simple method of determining the mean track length without measuring the lengths of individual tracks is described. This could be useful in giving some indication of the energy of the neutrons to which the radiation monitor has been exposed. (auth)

43288 EMERGENCY DOSIMETRY SYSTEM FOR NEUTRONS BASED ON BODY-SODIUM ACTIVATION. Mastrocola, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wurenlingen, Switzerland). pp 575-85 of STI/PUB-136.

A dosimetry system for criticality accidents is described which uses the natural sodium content of the body as the neutron detector by means of the $^{23}Na(n,\gamma)^{24}Na$ reaction and uses the body hydrogen as the fast neutron moderator. An end-window GM counter and a single-channel gamma spectrometer are used for the evaluation. (W.H.K.)

43289 VAN DE GRAAFF MEASUREMENTS WITH A PROTON-RECOIL COUNTER AND REM-COUNTER MEASUREMENTS AT THE RESEARCH REACTOR GEESTHACHT. Henning, K. D.; Janssen, U. A.; Mielken, G. N. (Kernenergieverwertung in Schiffbau und Schiffahrt G.m.b.H., Geesthacht, Ger.). pp 651-8 of STI/PUB-136.

At the Van de Graaff Generator of the Hamburg University the rem sensitivity of a proton-recoil counter was determined in the energy range from 0.1 to 6.3 MeV as a function of the discriminator bias level. The deviation from the mean rem sensitivity (counts/min per m.p.l.) was found to be within 20 to 50% at the different neutron energies, independent of the discriminator bias level. Neutron dose-rates have been measured at Geesthacht with a proton-recoil counter (FN2), and a rem and BF_3 counter with and without cadmium. The results show that the epithermal neutron component at the swimming pool reactor is about 10% and that the assumption of a 1/E spectrum for BF_3(Cd) measurements is in agreement with the rem-counter measurements. (auth)

43290 ASPECTS OF NEUTRON DOSIMETRY IN A PLANT FOR THE TREATMENT OF IRRADIATED FUEL ELEMENTS. Tabardel-Brian, Renee; Peyresblanques, H.; Sutra-Fourcade, Y. (CEA, Marcoule, France). pp 397-413 of STI/PUB-136. (In French).

The neutrons are produced primarily by the (α,n) reaction with fluorine, which is used in the final stage of the process. The problem of dose assessment was solved in two stages: Measurement of the spectra by multisphere detectors which, used in conjunction with a computer programme, makes it possible to obtain flux, neutron distribution and dose as a function of energy; and comparison of these results with the figures given by portable measuring instruments and the readings of personnel dosimeters called for interpretation of the discrepancies and for the correction, in the light of the results found with the spheres, of the values obtained with the detectors used. (auth)

43291 INTERPRETATION OF THE VARIOUS DOSIMETRIC DATA AVAILABLE AFTER GAMMA-NEUTRON IRRADIATION. Bricka, M. (Centre d'Etudes Nucleaires, Cadarache, France); Cercy, J.; Labat, Christiane; Berman, F.; Pages, J.-P. pp 587-600 of STI/PUB-136. (In French).

Flux and dose evaluation in a gamma-neutron field is very difficult because of the existence of secondary neutron sources

(scattering masses) and gamma sources ((n,γ) reactions on hydrogen). Several measuring systems were used in conjunction with the RACHEL critical assembly. These included SNAC neutron spectrometers, moderating spheres and personnel dosimeters (for neutrons) and film badges, glass dosimeters and thermoluminescent substances (for gamma radiation), as well as cans and phantoms containing sodium solutions. The data were processed by means of an IBM computer. The variation of flux and kerma with distance follows the $1/R^2$ law up to about 2 m. Beyond 2 m, the increasing importance of scattering justifies an approximate 1/R law, but the $1/R^2$ law reappears at large distances. The radiation field is considerably perturbed by large masses. Measurements carried out on cans and phantoms with personnel dosimeters and the measured ^{24}Na levels are interpreted and linked up with the measurements made in the same positions without cans or phantoms. (auth)

43292 DETERMINATION OF THE ^{24}Na ACTIVITY AND THE AUTOGAMMA DOSE FROM DATA OBTAINED WITH A SNAC SPECTROMETER. Morawek, Th. (Centre d'Etudes Nucleaires, Cadarache, France). pp 601-11 of STI/PUB-136. (In French).

From the data obtained with a SNAC neutron spectrometer, one can evaluate the ^{24}Na activity in the blood of a person placed in the same position as the instrument. The curve $\xi(E)$, given by Snyder and Neufeld, was used for the probability of neutron capture as a function of energy and the ^{24}Na activity is obtained from the formula: $A_{Na} = K\int\xi(E)\phi(E)dE$. The coefficient K can be determined either by calculation or by irradiating with monoenergetic neutrons. A special IBM computation program, developed for work with the spectrometer, was used to obtain a linear formula for calculating the sodium activity from the activities of the detectors comprising the spectrometer. The relationship between sodium activity and kerma was determined; this may vary by a factor of 10, depending on the character of the incident neutron spectrum. The same method can be used to determine the autogamma dose resulting from gamma rays produced by the (n,γ) reaction in the hydrogen of tissue and to study its effects on the gamma measurements obtained with personnel dosimeters. (auth)

Radiometric Instruments

Refer also to abstract 43204.

43293 (GEPP-5) RESUME OF RADIFLO LEAK DETECTION. Troutner, V. H. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). Apr. 7, 1967. Contract AT(29-2)-656. 21p. (R-67ND2). Dep. CFSTI.

Parameters and procedures for use of the Radiflo system for detecting leaks in product tubes are discussed; values are presented for essential parameters; and procedures are recommended. (auth)

43294 (Y-DA-1582) HAND-PROBE BETA BACKSCATTER GAUGE FOR RADIOACTIVE MATERIALS. Hobbs, R. A.; Cofield, R. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Aug. 7, 1967. Contract W-7405-eng-26. 32p. (CONF-671002-2). Dep. CFSTI.

From 27th National Fall Conference of the Society for Nondestructive Testing, Cleveland, Ohio.

A beta radiation backscatter gaging system, including a miniature probe head suitable for hand-held use, developed for measurements on radioactive test objects, is described. The miniature hand probe permits measurement on the inside surfaces of test objects as small as 3-inch spherical radius or 1.75-inch cylindrical radius. The probe collimator has a bilayer, graded shield structure of low Z and high Z metals to reduce both collimator internal backscatter and count rate contributions from radioactive test objects. Dual measurements, with and without the beta source, complete the elimination of error-producing effects of radioactive test objects. The system has been calibrated and used for material identification, uniformity studies, and coating thickness measurements on reactor components and fuel elements, radiation source containers, and other test objects. (auth)

43295 LIMITS OF THE USEABILITY OF ^{60}Co AND ^{137}Cs FOR NONCONTINUOUS LEVEL CONTROL. Plaksin, I. N.; Gol'din, M. L. At. Energ. (USSR), 22: 505-6(June 1967). (In Russian).

In view of their useful service life of 10 to 15 years, ^{60}Co and ^{137}Cs are widely used as radiation sources for level measurements. Calculations were carried out to determine the conditions of optimum application of these sources, keeping constant the distance between the source and the detector, the surface area and the wall thickness. The calculations revealed that for a service life of 15 years and an iron wall thickness up to 13 cm, the ^{137}Cs sources are preferable to the ^{60}Co ones. From the viewpoint of safety, the latter source is recommended for a thickness of 25 cm for a service life of 15 years and 19 cm for 2 years of operation. The effect of the temperature was not taken into account for the calculations. (TTT)

43296 X-RAY THICKNESS GAGE. STRIP THICKNESS MEASURING EQUIPMENT USING X RAYS. Kido, Hiroshi (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rev., Int. Ed., No. 30, 11-17(Apr.-June 1967).

Measurement of strip thickness is essential to process control in rolling or sheet lines in iron-and-steel or nonferrous-metal industries. The x-ray thickness gage, performing the measurement continuously without contacting with the strip, has very high utility. In addition to a description of the gage some examples of actual application are presented. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 43103, 43627, 43936, and 43994.

43297 (BNWL-451) A MODIFIED INSTRUCTION SET FOR THE FFTF INSTRUMENTATION PROTOTYPE. Draper, W. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

The Fast Flux Test Facility Instrumentation Prototype programming flexibility has been increased by making some inexpensive hardware changes in its instruction set. These changes, which include the addition of CAS (Compare and threeway Skip), SUB (one's complement subtract), and IAC (Increment the Accumulator) instructions, are discussed. (auth)

43298 (CEA-R-3182) ETUDE DE THERMOCOUPLES POUR LE REPERAGE DES HAUTES TEMPERATURES. (Study of Thermocouples for Control of High Temperatures). Villamayor, Michel (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 111p. (In French). Dep.

Thesis. Submitted to Univ., Lyon.

Previous works have shown that the tungsten-rhenium alloy thermocouples were a good instrument for control of high temperatures. The W/W 26% Re and W 5% Re/W 26% Re French manufactured thermocouples and intended for control of temperatures in nuclear reactors up to 2300°C were studied. In out-pile study the general characteristics of these thermocouples: average calibration curves, thermal shocks influence, response times, and alloys allowing the cold source compensation are determined. The evolution of these thermocouples under thermal neutron flux was determined by in-pile study. The observations have led to a proposal of a new type of thermocouple settled of molybdenum-columbium alloys. (auth)

43299 (KFK-509) RAUSCHEN EINES GEKUEHLTEN, LADUNGSEMPFINDLICHEN VORVERSTAERKERS MIT PARALLEL GESCHALTETEN FELDEFFEKT-TRANSISTOREN. (Noise of a Cooled, Load-Sensitive Preamplifier With Field-Effect Transistors Connected in Parallel). Tamm, U. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Feb. 1967. 10p. (In German). Dep.

A cooled load-sensitive preamplifier with field effect transistors connected in parallel is described and its circuit is given. Noise formulas are derived and the noise properties of the preamplifier are calculated. The optimum integration and differentiation time constants were determined. A comparison was made between the calculated and measured noise values. (J.S.R.)

43300 (N-67-25859) A STUDY TO DETERMINE AN EFFICIENT DATA FORMAT AND DATA SYSTEM FOR A LIGHTWEIGHT DEEP SPACE PROBE. Summary Final Report, October 1965-October 1966. Bello, L. M. (TRW Systems, Redondo Beach, Calif.). Oct. 31, 1966. Contract NAS2-3254. 28p. (NASA-CR-73084). CFSTI.

This study has resulted in the definition and overall design of a Central Data System (CDS) for a spin stabilized deep space probe. The CDS consists of an input data sampler and a central processor. Digital and analog data is received by the CDS from the experiments and from the spacecraft performance sensors. This data is sampled by the input data sampler and processed by the central processor into a highly efficient format for storage or transmission. Data processing is programmable and under the control of a stored program. The CDS processes discrete commands and processor program instructions from ground transmissions. The CDS design is based on a group of eight solar experiments chosen for the study by mutual discussion and

agreement with NASA/ARC. These are: micrometeoroid, flux gate magnetometer, plasma probe, radio propagation, fast neutron detector, very low frequency, and cosmic ray detector. Each of these experiments was studied in detail to determine their interface requirements in terms of the number of inputs to be sampled by the CDS, input signal characteristics, required data processing, timing requirements, and sensor control signals. (auth) (STAR)

43301 (ORNL-TM-1950) PROGRAM WEIGHT: A FORTRAN IV PROGRAM FOR EVALUATION OF WEIGHTING FUNCTIONS USED IN SMALL-ANGLE X-RAY SCATTERING. Buchanan, Mary G.; Hendricks, Robert W. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 54p. Dep. CFSTI.

A FORTRAN IV program is presented which evaluates the weighting functions needed to correct observed small-angle x-ray scattering data for the smearing effects of the collimation system. Moments of the weighting functions about both the origin and the mean may also be computed from the program described. (auth)

43302 (UCRL-70632) SMALL-DIAMETER TUBE EVALUATION WITH EDDY CURRENTS AND ULTRASONICS. Peck, H. E.; McKinley, B. J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1967. Contract W-7405-eng-48. 8p. (CONF-670903-13). Dep. CFSTI.

From 22nd Instrument-Automation Conference and Exhibit, Chicago, Ill.

The nondestructive evaluation of $\frac{1}{16}$- and $\frac{1}{8}$-inch o.d. stainless steel tubing is described using eddy-current and ultrasonic techniques. The noncommercial instrumentation and fixturing developed to evaluate this tubing, the problems encountered, and the future instrumentation requirements are discussed. Typical test results and correlation with photomicrographs are included. (auth)

43303 DERIVATION OF SOME RELATIONS CHARACTERIZING THE BASIC PARAMETERS OF A MASS SPECTROMETER. Slobodenyuk, G. I. Zh. Tekh. Fiz., 37: 964-70(May 1967). (In Russian).

Among the parameters characterizing the merit of a mass spectrometer are the following: (1) the mass resolving power; (2) the range of working pressures; (3) the range of recorded masses; (4) the sensitivity (the minimum partial pressure of a given mass component that can be recorded); (5) the sensitivity of the partial pressure detector (the current at the output of the detector per unit partial pressure of a given component); and (6) the recording rate (the number of complete spectra recorded per unit time). The author derives relations among these parameters and parameters characterizing certain external circumstances (such as the band width and noise factor of the amplifier, the characteristics of a secondary electron multiplier possibly employed in the detector, and others), which can be employed for optimizing the design of a mass spectrometer. A mass spectrometer figure of merit depending on these and other parameters is derived and its value is given for several Soviet mass spectrometers. (ATD)

43304 DUAL MASS SPECTROMETER WITH AN INHOMOGENEOUS MAGNETIC FIELD. Shekhovtsov, N. A.; Shkuroda, V. F.; Kuzema, A. S.; Koloskov, A. S. At. Energ. (USSR), 22: 506-10 (June 1967). (In Russian).

The resolution of a mass spectrometer with a homogeneous field depends primarily on the radius of the ion trajectory, or dispersion. A nonhomogeneous field presents the advantage that it does not possess geometric aberrations; design of the industrial, MS-62 type mass spectrometer is based on such considerations. The instrument may be filled alternately with the reference gas and the unknown sample; its electromagnetic valves may be operated remotely. Sensitivity of the system is better than 0.001%; the radius of its ion trajectory is 1500 mm while the accelerating voltage ranges from 1000 to 2500 v. The mean relative error in the measurement of isotopic ratios is below 0.2%. (TTT)

43305 USE OF A QUARTZ CONTAINED DISCHARGE IN ATOMIC TRITIUM EXPERIMENTS. Mathur, B. S. (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instrum., 38: 1536(Oct. 1967).

The rapid loss of tritium and the rapid evolution of hydrogen in the rf discharge is reported to be greatly reduced by using a quartz discharge bulb rather than a Pyrex bulb. The tritium-loss mechanisms were found to be diffusion into the discharge bulb wall and exchange with the hydrogen in the discharge and elsewhere in the vacuum manifold. (W.H.K.)

43306 COLD CATHODE QUADRUPOLE MASS SPECTROMETER. Blum, P.; Torney, F. L. (National Research Corp., Cambridge, Mass.). Contract NAS1-2691. Rev. Sci. Instrum., 38: 1404-8(Oct. 1967).

A magnetron cold cathode ion source (CCIS) was developed for ultrahigh vacuum residual gas analysis. The purpose is to eliminate the spurious spectra produced by the conventional hot filament source and to obtain greater sensitivity. A commercial quadrupole mass analyzer was used to evaluate source performance and potential. Resolution equaled that obtained with a hot filament source, giving mass invariant peak separations, with 10% valleys, of 1.0 amu below 150 amu and 0.7 amu below 50 amu. Sensitivities exceeded those obtained with a hot filament source, operated at a 3 mA emission current, by factors of 1.5 to 4.6, depending on pressure and mass. The corresponding CCIS sensitivities, at 1-amu peak separation, were 0.4 mA/torr for mass 28 at 3×10^{-9} torr and 1.2 mA/torr for mass 40 at 1×10^{-7} torr. Experiments indicated a potential tenfold further sensitivity improvement if a quadrupole with a higher rf potential were used; by increasing quadrupole dimensions a still greater fraction of the source internal sensitivity, which is in the vicinity of 1 A/torr, may be realized. (auth)

43307 SIMPLE TUNNEL DIODE CIRCUIT FOR ACCURATE ZERO CROSSING TIMING. Metz, Arthur J. (Argonne National Lab., Ill.). Rev. Sci. Instrum., 38: 1445-9(Oct. 1967).

A simple tunnel diode circuit capable of accurately timing the zero crossing point of bipolar pulses is described. The combination of a fast tunnel diode and a nonlinear load line results in a circuit that can detect the zero crossing of a wide range of input waveshapes. This technique has been utilized in the design of a versatile, fast zero crossing discriminator. This instrument, which is compatible with existing logic systems, exhibits time slewing of less than 200 psec for an input amplitude range of at least 1 to 70 times threshold. Direct coupling and extremely short recovery time enable the instrument to function well at rates as high as 50 MHz. (auth)

43308 TIME-CONSTANT REDUCTION IN CHARGE-SENSITIVE PREAMPLIFIERS. Goldsworthy, W. W. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 54: 301(Oct. 1967). (UCRL-17570).

A technique is described for reducing the time-constant of a charge-sensitive amplifier without reducing the size of the feedback parameters. (auth)

43309 SIMPLE PREAMPLIFIER FOR USE OF 10-STAGE PHOTOMULTIPLIERS WITH COMMERCIAL NANOSECOND ELECTRONICS. Krehbiel, H. (DESY, Hamburg). Nucl. Instrum. Methods, 54: 302-4(Oct. 1967).

An ac-coupled preamplifier of gain 8 is described which allows the use of 10-stage miniature photomultipliers with commercial nanosecond electronics in high energy hodoscope applications. The preamplifier is located close to the photomultiplier base. Its essential components are a step-down autotransformer and a common base transistor stage. (auth)

43310 GERMANIUM FET: A NOVEL ELEMENT FOR LOW-NOISE PREAMPLIFIERS. Elad, E.; Nakamura, M. (Univ. of California, Berkeley). Nucl. Instrum. Methods, 54: 308-10 (Oct. 1967).

A preamplifier based on germanium FET's and having 0.3 keV resolution is described. (auth)

43311 D-REGION MOBILITY SPECTROMETER. Hoult, D. P. (Pennsylvania State Univ., University Park. Massachusetts Inst. of Tech., Cambridge); Kuo, Ta-jin. J. Geophys. Res., 72: 4529-32(Sept. 1, 1967).

The possibility of a mobility spectrometer is discussed. A theory of the device is presented that is applicable in the 40 to 70-km altitude range. As the device is based entirely on continuum concepts, no fine grids or vacuum pumping capacity is required. The device measures the mobility and abundance of the various constituents. The resolution of this device in mobility is 2.5%. (auth)

43312 FAST SIXTEEN CHANNEL ANALYSER. Alberigi Quaranta, A.; Righini, B.; Volta, R. (Univ., Bologna). Nucl. Instrum. Methods, 54: 199-211(Oct. 1967).

A fast 16-channel pulse-height analyzer fitted for use in high-energy physics experiments is described: its over-all dead-time is about 1 μsec. The circuit diagram and the performances of the analyzer are reported. (auth)

43313 DIGITAL LEVEL TELEMETER. Sastri, M. V. S.; Bhatt, S. M. V.; Kanitkar, J. V.; Pande, K. C.; Telang, S. M. (Atomic Energy Establishment, Trombay, India). Nucl. Instrum. Methods, 54: 261-7(Oct. 1967).

An optical encoder used in conjunction with a precision machined drum enables the heavy-water level in a research reactor to be measured with a differential accuracy of 0.1 mm. Details of the encoder logic and system operation are given. (auth)

43314 HIGH-FIELD MICROWAVE GENERATING ARRANGEMENT. Consoli, Terenzio; Le Gardeur, Rene; Mourier, Georges (to Commissariat a l'Energie Atomique). British Patent 1,086,235. Oct. 4, 1967. Priority date Feb. 12, 1965, France.

A microwave system consisting of klystron having two interaction spaces and a feedback loop which comprises an isolator in series with a resonant cavity is described. (M.O.W.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 44201.

43315 (AD-651760) ELECTRON IRRADIATION OF P-CHANNEL JUNCTION FETs. Stanley, A. G. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). Apr. 13, 1967. Contract AF19(628)-5167. 35p. (TN-1967-20; ESD-TR-67-239). CFSTI.

The resistance of p-channel junction FETs to electron irradiation in high impedance nanoamp circuit applications is limited by the leakage current across the gate junction. The dependence of the leakage current on electron flux and total dose was investigated by electron irradiation in vacuum. The increase in leakage current was found to be primarily due to an increase in surface recombination velocity. It was independent of the electron flux over the range from 3×10^9 to 10^{12} e/sq cm/sec with some indication of a reduction in leakage current at lower fluxes. An anomalously high leakage current due to channel formation developed in some devices at total doses above 10^{14} e/sq cm. (auth) (TAB)

43316 EFFECTS OF HIGH ENERGY RADIATIONS ON NOISE PULSES FROM PHOTOMULTIPLIER TUBES. Jerde, Roderick L. (Univ. of California, San Diego, La Jolla); Peterson, Laurence E.; Stein, Wayne. Rev. Sci. Instrum., 38: 1387-94(Oct. 1967).

Changes in the dark current and noise pulse spectrum of photomultiplier tubes due to ionizing radiations are reported. Tubes studied were the RCA 7265 and various versions of the ruggedized RCA 6199. Measurements were made both at 25 and −40°C under exposure to ^{60}Co γ rays, cosmic rays, ^{241}Am alpha particles, and ^{90}Sr β rays. All ionizing radiations incident on the phototube face were observed to produce additional dark current, and a considerable enhancement of the pulse spectrum, particularly at pulse sizes corresponding to several cathode photoelectrons. Each cosmic ray and interacting ^{60}Co γ ray produced one large pulse, equivalent to about 10 single photoelectrons, and about 10 smaller pulses. The ^{241}Am and ^{90}Sr produced less than one noise event per incident particle. In order to explain the effects, three mechanisms seem to be required. Cherenkov radiation will produce the large pulses due to relativistic cosmic rays and Compton scattered electrons by ^{60}Co γ rays. Scintillations in the glass with an efficiency of about 10 photons/MeV produce the effects due to the nonrelativistic alpha and β particles. It is suggested that phosphorescence induced by the short wavelength Cherenkov quanta can account for the many small pulses observed. These effects significantly alter the signal-to-noise characteristics of phototubes on balloons and satellites when applied to the detection of weak light sources, or low intensity x rays in the environment of space. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 43409, 43410, and 44160.

43317 (COO-690-20) I. DENATURATION OF ENZYMES BY THE DIRECT ACTION OF IONIZING RADIATION. II. ENZYMICALLY ACTIVE COMPONENTS OF THE CRYSTALLINE CHYMOTRYPSINS. Henderson, Louis Edwin (Colorado Univ., Boulder. Dept. of Chemistry). 1966. 70p. Dep. CFSTI.

Thesis.

The inactivation of alpha-chymotrypsin by the direct action of gamma radiation was shown to be an all-or-none process. No chemically altered but enzymically active molecules produced by irradiation could be detected by ion exchange chromatography or gel electrophoresis. Alpha-chymotrypsin required an average dose of 42.1 eV/molecule to inactivate the enzyme in the solid state. Reaction mechanisms involved are discussed. (C.H.)

43318 (COO-1485-13) RADIOISOTOPE CYCLING IN TERRESTRIAL COMMUNITIES AT ENIWETOK ATOLL. Jackson, William B.; Carpenter, Michael L. (Bowling Green State Univ., Ohio). May 15, 1967. Contract AT(11-1)-1485. 13p. (CONF-670503-25). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Current studies of rat populations on Eniwetok Atoll are reported. In cooperation with the Laboratory of Radiation Biology, University of Washington, tissue samples of various land vertebrates and plants were collected and analyzed for radioisotope content. The ^{137}Cs data for rats and their principal food sources are discussed. (E.R.B.)

43319 (ORNL-TM-1927) EXPERIMENTALLY DETERMINED PROTON-RECOIL SPECTRA IN TISSUE-EQUIVALENT MATERIAL FROM 3- AND 15-MeV NEUTRONS. Stone, G. F.; Thorngate, J. H. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 85p. Dep. CFSTI.

An experiment was conducted to measure the energy spectrum of charged particles produced as a function of position in a tissue-equivalent phantom irradiated with monoenergetic 3- or 15-MeV neutrons. The charged particles were measured with semiconductor detectors that were covered with a thin coating of Marvethane to protect them from the sugar-urea tissue-equivalent solution. One detector was a surface barrier transmission type, and the other was a Li-drifted Si detector in the shape of a cube. The second detector had four sides which had no dead layer so that recoil O, N, and C ions were measured as well as recoil protons. Data obtained are consistent with theories of neutron moderation. Careful measurements were made to determine the contribution of n,p and n,α reactions in the detectors and the effects of neutrons scattered from the walls and floor surrounding the experimental set up. These contributed less than 10% under worst case conditions. The data obtained will be compared with the results of a computational program now underway to verify the calculations. (auth)

43320 (RLO-1927-18) COMPREHENSIVE REPORT OF OVERALL ACTIVITIES. Progress Report. Siegel, Benjamin V. (Oregon Univ., Portland. Medical School). [1967]. Contract AT(45-1)-1927. 10p. Dep. CFSTI.

Progress is reported on the following studies: effects of hyperbaric oxygen on body weight and weights of liver and adrenal glands of mice; alterations in hematologic patterns and hemopoietic tissue histology in mice following immunization with complete Freund's adjuvant; effects of deuteration on circulating antibody levels in mice; experimental distinction between the effects of D_2O acting as solvent and source of readily exchangeable hydrogen isotope and D_2O acting as a source of non-exchangeable isotope incorporated by synthesis into C-D bonds; effects of bovine serum albumin on antibody response in young adult mice immunized with BSA in complete Freund's adjuvant, 3, 10, or 18 days before infection with leukemogenic virus; development of a multiple wavelength selector for continuous spectrophotometric column monitoring system; ultrastructure of antibody release from plaque-forming cells; potentiation of the immunosuppressive effects of cytoxan by hyperbaric oxygen; establishment of NZB mouse colony; and demonstration of increased immunologic responsiveness in NZB mice. A list of 16 references to papers published on this work is included. (H.L.W.)

43321 (UCRL-17779) ELECTRON PARAMAGNETIC RESONANCE STUDIES OF PHOTOSYNTHETIC SYSTEMS. Gentner, Donald Richard (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 92p. Dep. CFSTI.

Thesis.

There are two main questions to be asked about the electron paramagnetic resonance signals observed in photosynthetic systems: are the signals directly related to photosynthesis, and what is the molecular species responsible for the signal? Articles in the literature relevant to these questions are reviewed. Most of the experiments reported here were performed using an EPR spectrometer with superheterodyne detection and a digital averaging computer. Samples were maintained at temperatures between 1.5°K and room temperature. The preparation of a chromium sample, which has many advantages as an internal standard for the EPR spectrometer, is described. Dried films of whole cell R. rubrum had a small EPR signal in the dark. Illumination at room temperature resulted in two reversible light-induced signals, one with a decay time of a few seconds, the other with a decay time of a few hours. Small reversible light-induced EPR signals were observed in R. rubrum down to temperatures below 8°K. The kinetics of the photochanges were measured at temperatures between 1.7°K and room temperature, and in most cases, the rise and decay curves could be fitted by two exponentials. The rise and decay rates of the EPR signal increased rapidly as the temperature was lowered from room temperature to 200°K; below 200°K the rates were approximately constant. Although EPR signals of some metals have been seen at low temperature, a search for signals due to triplet states was unsuccessful. At room temperature, illumination with saturating light intensity produced one unpaired electron for every 55 bacterial chlorophyll molecules. Identifying the light-induced EPR signal in R. rubrum with the 433 nm absorbance change, the extinction coefficient at 433 nm of the molecule responsible for both the EPR and OD changes was estimated to be approximately 4×10^4 l/m cm. This calculation was combined with other evidence to suggest that a flavin was a likely candidate to be the molecule associated with the photo-induced EPR signal. (auth)

43322 ENTRY OF RADIOACTIVE MATERIALS INTO PLANTS. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 87-104 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The absorption, redistribution and retention or loss of radioactive contaminants by plants are discussed. The direct contamination of plants involves the deposition of air-borne materials on their above-ground parts, while indirect contamination is limited to root absorption, of radioactive materials that have entered the soil. Direct contamination occurs only when fallout contacts growing crops, while the extent of indirect contamination depends on the accumulated deposit in the soil. The presence of long lived radioisotopes in the soil makes the latter route an increasingly important factor. Differences in the mechanisms of contamination for annual and perennial plants are discussed. Factors affecting the rate of absorption include concentration, chemical characteristics, and interrelations between ions, and pH of the rhizosphere. Redistribution of absorbed ions in the plant depends mainly on the valence of the ion in question. Bivalent and multivalent cations are much less mobile than are the monovalent cations. They move rapidly through the xylem to the leaves, but from there very little is redistributed. With the exception of ^{137}Cs, all of the important fission products of appreciable half-life fall into this low-mobility category. (E.R.B.)

43323 BEHAVIOR OF RADIOACTIVE MATERIALS IN SOIL. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 105-26 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Both the factors affecting the availability of radioactive materials to plants immediately after they enter the soil and the manner in which their availability may change with time are discussed. Regarding entry into the plant, ions contained in the soil may be placed into three general categories; ions in soil solution, readily exchangeable ions on mineral or organic surfaces, and ions held in very sparingly soluble components. Ions in the first two categories constitute those ions readily available to the plant, while ions in the third category are not readily available. The availability of these latter ions is influenced mainly by weathering processes, and may with time attain the same status as those in the first two categories. Oxidation by microorganisms and hydrogen ion concentration may also facilitate this change in status. The

mechanisms of lateral and downward movement of fission products deposited on the surface of the ground are discussed. Whether movement is by diffusion or mass flow would greatly influence the availability of radioisotopes to the absorption zones of plant roots. The relative order of entry of fission products into plant roots from the soil is given as follows: ^{90}Sr, ^{137}Cs, ^{106}Ru, ^{144}Ce, ^{95}Zr, and ^{239}Pu; this is a generalization based on a number of investigations. (E.R.B.)

43324 RADIOACTIVE MATERIALS IN ANIMALS: ENTRY AND METABOLISM. Comar, C. L. (Cornell Univ., Ithaca, N. Y.). pp 127-57 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Generalizations are presented that may be helpful in assessing the activity of radioisotopes in animal tissues and milk. Data for domestic animals on amount and mineral content of tissues and excretions, feed intake, and air intake are given. These approximations are based on absorption through the skin, inhalation, and ingestion of the substances considered. The level of activity of radioisotopes, following absorption, by any tissue is the product of several, often competing, processes. These processes include; excretion, secretion, deposition, and transfer, as across the placental barrier. The principles involved in the consideration of feeding practices in relation to patterns of contamination of feed are also discussed. In this regard, of prime importance is the management of pastures where domestic animals are kept. It is pointed out that in abundant, well fertilized pastures, the levels of ^{90}Sr and ^{131}I in forage were reduced by a factor of 50% as compared to forage from poorly fertilized pastures. (E.R.B.)

43325 ENTRY OF ^{90}Sr INTO PLANTS FROM THE SOIL. Russell, R. Scott; Newbould, P. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 213-45 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Owing to its long half-life, the content of ^{90}Sr in soil is of primary importance over a period of time in the entry of this isotope into the plant. Brief but intense fallout would account for increased direct contamination of plants, but it is the long range effects of soil deposition that are of most concern. The extent to which the ^{90}Sr in the soil enters the plant depends on the concentration in the plant of both stable Ca and Sr. Another factor determining the amount of ^{90}Sr entering the plant from the soil is the inability of ^{90}Sr to penetrate the soil. Only seven percent of the ^{90}Sr at the surface of the soil penetrates beyond 13 cm. Availability of ^{90}Sr, chemically, to the plant was shown to be only a minor factor. Other factors influencing the entry of ^{90}Sr into plants from the soil included the following: calcium status of the soil, soil type, and use of fertilizers. Sixty-nine references are cited. (E.R.B.)

43326 AUTOMATIC DATA PROCESSING IN NUCLEONIC ISOTOPE STUDIES. Bio-Med. Eng. (London), 2: 272-4(June 1967).

A survey is given of recent advances in automatic data processing in radioisotope studies. Modern medicine needs automatic methods to handle the volume of counting work and the subsequent computation and data presentation. This very large volume of work is due to the effectiveness of radiotracer methods, that are being applied to an ever-increasing number of problems. There is a likelihood of automatic sample changers becoming as widely used as automatic liquid scintillation sample changers. Several methods for computerized interpretation of γ scans are outlined. Improvements in manual counting instruments, automatic counting instruments, and scanners and cameras are discussed. Photomultipliers have improved so much that it is now possible to change greatly the gain at which they operate without degrading either stability or pulse height resolution. Therefore, instruments should now conform to conventional practice by eliminating amplifier gain controls and discriminator controls except as presets. The front-end performance of scanners and cameras is now approaching optimum. It appears to be possible to obtain field uniformities approaching 1% and resolution limited only by the activity that can be safely used. (BBB)

43327 PROTEIN-SYNTHESIZING FUNCTIONS OF RIBOSOME STUDIED BY ULTRAVIOLET IRRADIATION. Kagawa, Haruo (Kyoto Univ.). Seibutsu Butsuri, 5: 314-24(Nov. 1965). (In Japanese).

Ribosomes were extracted from the H strain of Escherichia coli and irradiated with ultraviolet. Polyphenylalanine was synthesized using polyuracil and ^{14}C-phenylalanine. Protein synthesis in intact ribosomes was not affected by uv-inactivated ribosomes. Survival cross-sections for ribosomes inactivated by ultraviolet radiation are given, and the significance of these values in protein synthesis is pointed out. (NSA of Japan) (TSS)

43328 THE ROLE OF PEROXIDES IN THE INHIBITION OF DNA SYNTHESIS IN CELLS FOLLOWING IRRADIATION WITH A UV MICROBEAM. Dendy, P. P.; Smith, C. L.; Aebi, H. E. (Univ. of Cambridge, Eng.). Photochem. Photobiol., 6: 461-7 (July 1967).

The rate of DNA synthesis in mammalian cells can be reduced when a microbeam of uv light is directed into the medium surrounding the cells; 'nformation on the mechanism of this effect was obtained. Results showed that catalase protects cellular DNA synthesis under the following conditions: the microbeam must be directed into the surrounding medium; there is no protection if it strikes any part of the cell; the catalase must have been in contact with the cells for at least four hr before irradiation, and at high doses of radiation the protection is only partial. The catalase was labeled with fluorescent dye to demonstrate that it can penetrate the cell cytoplasm but not the nucleus. Morphologic studies on cells exposed to medium containing hydrogen peroxide showed that protection was provided by intracellular and not extracellular catalase, and supported the idea that the toxic product produced by uv irradiation of the medium was ultimately a peroxide. (BBB)

43329 IN VIVO AND IN VITRO EXPERIMENTS ON ELIMINATION OF RADIOACTIVE STRONTIUM DEPOSITED IN BONE. II. Ogawa, Eiichi; Suzuki, Shiro; Tsuzuki, Hiroshi (Gunma Univ., Maebashi, Japan). Gunma J. Med. Sci., 15: 32-8(Mar. 1966).

Adult mice of the ddN strain were injected with ^{85}Sr, and after 24 hr were sacrificed and the femur assayed in a well-type scintillation counter. Then the femurs were incubated at 37°C in various media with or without addition of various agents and after 1 hr, the radioactivity of the medium was determined. The ^{85}Sr elution rate remained unchanged within the range of pH four to eleven, adjusted with HCl or NaOH, but under pH three it increased sharply, and decreased rapidly when pH was above 12. Changes in the elution rate produced by various chelating agents were nearly proportional to their stability constants for Sr (or Ca) and their concentrations. When the agent's concentration was high, the elution rate was significantly elevated, but it sometimes fell significantly in low concentration. Effects of salts on the elution rate were also tested. Whereas KCl (0.1 to 0.25M) elicited no change, $MgCl_2$, $CaCl_2$, and $BaCl_2$ (0.05 to 0.15M) increased the elution rate in proportion to the concentration. The $SrCl_2$ solution had the greatest effect. Ringer's solution also elevated the rate, whereas 0.1M Na_2CO_3 remarkably inhibited elution while $ZnSO_4$ (0.01 to 0.15M) did not exert any effect; Pb acetate (0.02M), Al silicate (0.01M), and Ca pantothenate (0.01M) increased the Sr elution rate. It was also elevated by the addition of ion exchange resins such as Amberlite IRC 50, but was lowered to 50% of the control by addition of 5% glucose. Addition of Na chondroitin sulfate or Na heparin did not elicit any change, nor was any effect noted after addition of the hormones prednisolone, parotin (salivary gland hormone), parathyroid hormone, growth hormone, and thyroxine. (BBB)

43330 EFFECT OF ULTRAVIOLET RADIATION ON AUXIN-CONTROLLED ABSCISSION. Klein, Richard M. (New York Botanical Garden, N. Y.). Ann. N. Y. Acad. Sci., 144: 146-53 (Aug. 9, 1967).

Irradiation of plant cells causes photoreactable lesions in the metabolic systems which are involved in the capacity of the cells to utilize auxin. This uv-induced auxin recalcitrance has been studied in two auxin-auxotrophic abscission systems in vivo and in vitro. Available evidence suggests that the uv lesion is at the ribonucleic acid level. (auth)

43331 PROGRESS IN BIOPHYSICS AND MOLECULAR BIOLOGY. VOLUME 17. Butler, J. A. V.; Huxley, H. E. (eds.). Progr. Biophys. Mol. Biol., 17: 1-392(1967).

Eight chapters are included in the book. Separate abstracts were prepared on two. Other topics discussed are: the contractile mechanism of insect muscle; ribonucleic acid and hormonal control of protein synthesis; genes and cellular differentiation; and the photochemical and macromolecular aspects of vision. (H.L.W.)

For abstracts of individual chapters see: 43332 and 43333.

43332 THE FORMATION OF RADICALS IN NUCLEIC ACIDS, NUCLEOPROTEINS, AND THEIR CONSTITUENTS BY IONIZING RADIATIONS. Mueller, Adolf (Kernforschungszentrum, Karlsruhe, Ger.). Progr. Biophys. Mol. Biol., 17: 99-147(1967).

The following aspects of radiation effects on formation of radicals in nucleic acids and nucleoproteins are reviewed: the significance of free radicals in radiobiological processes; ESR spectrometry of nucleic acid constituents; ESR spectrometry of nucleic acids; and ESR spectrometry of nucleoproteins. (H.L.W.)

43333 THE EFFECTS OF RADIATIONS ON DNA BIOSYNTHESIS AND RELATED PROCESSES. Shooter, K. V. (Royal Cancer Hospital, London). Progr. Biophys. Mol. Biol., 17: 289-323(1967).

The following aspects of radiation effects on DNA are reviewed: chemical and physical changes produced in DNA by radiation; synthesis of DNA and RNA in vitro; repair mechanisms; DNA synthesis in bacteria; RNA synthesis in bacteria; mammalian cells; and radiation sensitivity and genetic complexity of DNA. (H. L. W.)

43334 INACTIVATION OF BUdR-SUBSTITUTED TRANSFORMING DNA BY MONOCHROMATIC UV LIGHT OF VARIOUS WAVELENTHS. Mennigmann, Horst-Dieter (Johann-Wolfgang-Goethe-Univ., Frankfurt am Main). Mol. Gen. Genet., 99: 76-87(1967). (In German).

Incorporation of 5-bromodeoxyuridine (BUdR) sensitized the inactivability by uv of transforming DNA of Bacillus subtilis. The sensitization towards monochromatic uv between 230 and 350 nm was studied for unifiliarly and bifiliarly substituted DNA. The results for irradiation at 230 and 320 nm indicated that unifiliarly substituted DNA (TB) behaves like a 1:1 mixture of unsubstituted (TT) and bifiliarly substituted (BB) DNA. Since this is in accordance with that found (for long wavelength uv only) for phage λ, the result for 320 nm irradiation indicated that the uv-induced lesions within the substituted strand interfered with the transcription rather than with the replication mechanism. This is in contrast to what is known about the lesions induced in unsubstituted DNA by uv of 260 nm. The inactivation curve for TB for irradiation with uv of 260 or 290 nm simulated a 1:1 mixture of TT and BB only down to about 10% survivors. With higher doses the survival was lower than expected for a 1:1 mixture, indicating that at higher doses small amounts of photoproducts were produced in which both strands were involved. In contrast to phage λ, transforming DNA gave these results without a radioprotective substance. How far, in the case of phage λ, the greater local DNA concentration and the protein coat can explain this difference is discussed. (BBB)

43335 THE FORMATION OF RADICALS IN NUCLEIC ACIDS, NUCLEOPROTEINS, AND THEIR CONSTITUENTS BY IONIZING RADIATIONS. Mueller, A. (Inst. for Radiobiology, Karlsruhe, Ger.). Prog. Biophys. Mol. Biol., 17: 99-147(1967).

A review is given under the following heading: Significance of free radicals in radiobiological processes; ESR spectrometry of nucleic acid constituents (correlation of observed spectral features to radicals, modifications of ESR spectra, identification of radicals in thymine derivatives, other pyrimidine derivatives, purine derivatives, saturation of radical concentration, determination of radical yields); ESR spectrometry of nucleic acids (identification of induced radicals, thymine radicals and octet spectrum, other radicals and spectral features, efficiency of radical production, effects of oxygen and water, other parameters, temperature effects, bromouracil-substituted DNA); ESR spectrometry of nucleoproteins (nucleic acid-protein complexes, bacteriophage, and the effects of the addition of sulphur compounds). A section is devoted to conclusions, and an extensive bibliography is included. (UK)

43336 MATHEMATICAL ASPECTS OF THE ULTRAVIOLET PHOTOCHEMISTRY OF PYRIMIDINE DINUCLEOSIDE PHOSPHATES. Brown, I. H.; Johns, H. E. (Univ. of Toronto). Photochem. Photobiol., 6: 469-83(July 1967).

A mathematical formulation of the kinetics of dimer and hydrate formation in pyrimidine dinucleosides upon uv radiation is presented. The formation allows for the possibilities of forming a number of types of dimers each with different cross sections for formation and reversal, and of forming photo-irreversible products such as hydrates. The general differential equations describing the kinetics are solved in terms of a series of exponential terms which are functions of all the cross sections. The way in which any given species of photoproduct is dependent upon the cross sections is illustrated in several examples. The results have been used to predict the maximum amount of dimer which may be produced for a given set of cross sections and the exposure at which this maximum is expected. The conditions under which dimers may be detected in a mixture of parent and dimer upon re-irradiation at short wavelengths are examined in terms of the differential equations. (BBB)

43337 EFFECT OF ESTROGENS, IRRADIATION, AND ACTINOMYCIN D ON ENZYMES CONCERNED WITH LIPID METABOLISM. de Vellis, J.; Schjeide, O. A. (Univ. of California, Los Angeles). Progr. Biochem. Pharmacol., 2: 276-82 (1967).

Conspicuous changes in enzyme activity that might be related to estrogen-induced lipogenesis in the liver of chickens was investigated by assaying the soluble enzymes alkaline phosphatase, glycerol phosphate dehydrogenase, isocitrate dehydrogenase, lactate dehydrogenase, malate dehydrogenase, and malate dehydrogenase (decarboxylating) (NADP). The most consistent change in enzyme activity following the injection of estrogen was a rapid increase in the activity of malic enzyme. Only negligible changes occurred among the other enzymes tested although there appeared to be a slight increase in the activity of isocitric dehydrogenase and a slight decrease in alkaline phosphatase activity. The activity of malic enzyme was assayed as a function of the age of the fowl. In embryos and chicks up to 4 days of age there was practically no malic enzyme and none could be induced by injection of estrogenic substances; in control 7-day-old chicks the activity was relatively high and more activity could not be induced by estrogens. The same results were observed in 3-month-old fowl; however, production of lipids was sharply increased by the estrogen treatment. In adult roosters the situation was reversed. Actinomycin D (150 μg/kg) given 24 hrs prior to assay of the liver resulted in a sharp curtailment of the estrogen-stimulated increase of malic enzyme even in the presence of excessive estrogen. The administration of 200 R of γ radiation 24 hrs prior to sacrifice of the animals did not seem to affect malic enzyme activity in the liver of three-day estrogenized roosters. Some of the irradiated non-estrogenized animals died. It was concluded that further experimentation was needed to assess the effects of radiation. (B.H.S.)

43338 STUDIES ON THE RETENTION AND METABOLISM OF INHALED METHYL IODIDE. II. METABOLISM OF METHYL IODIDE. Morgan, A.; Morgan, D. J.; Evans, J. C.; Lister, B. A. J. (Atomic Energy Research Establishment, Harwell, Eng.). Health Phys., 13: 1067-74(Oct. 1967).

Experiments are reported in which methyl iodide, labelled with ^{132}I, was administered by inhalation to volunteer subjects to study the metabolism of the retained material. The fate of radioiodine administered in this way appeared to be very similar to that of radioiodine administered diagnostically as inorganic iodide. This was confirmed by a comparison of thyroid uptake and urinary excretion rates observed after administration of ^{132}I to the same subject by inhalation of methyl iodide and ingestion of sodium iodide. It appears therefore that, in vivo, methyl iodide is broken down very rapidly, the organically bound iodine being converted to the iodide ion. The radiation dose to the thyroids of volunteer subjects from radioiodine uptake was quite small, averaging less than 20 mrem per experiment. (auth)

43339 MATHEMATICAL ANALYSIS OF EXPERIMENTS WITH LABELED HORMONE TRACERS: PROBLEMS OF INTERPRETING TISSUE RADIOACTIVITY. Braunsberg, Hannelore; James, V. H. T. (St. Mary's Hospital Medical School, London). J. Clin. Endocrinol. Metab., 27: 1174-88(Aug. 1967).

Simple mathematical models were developed for tracer experiments using single intravenous administration, local application to an organ under study, injection into a tissue or body cavity, and constant intravenous infusion. Equations were derived for tissues driven by the plasma compartment and for tissues (such as the fetal-placental unit) constituting a distinguishable pool. Results of published work with labeled steroid tracers are discussed from the point of view of tissue kinetics. (76 references.) (auth)

43340 ON THE NATURE OF FREE RADICALS INDUCED BY X-RAYS IN PURIC BASES. Lacroix, M.; Depireux, J.; Van de Vorst, A. (Univ., Liege. Institut d'Astrophysique, Cointe-Sclessin, Belg.). Proc. Nat. Acad. Sci. U. S., 58: 399-401(Aug. 1967).

Much work using electron spin resonance has been devoted to x- and γ-ray-induced free radicals in the constituents of DNA with a view to deducing information about the effects of ionizing radiations on this macromolecule. New information about the nature of the free radicals produced in the isolated puric bases is reported, with emphasis on the evolution of spectroscopic splitting factor in the following series of purines: adenine, guanine, xanthine, hypoxanthine, and uric acid. Dry purines were x irradiated in vacuo and then examined with a Varian type 4502-06 spectrometer fitted with a dual sample cavity and modulated at 100 kc/second. All g-factor measurements were performed by graphical interpolation between the two centermost lines of Mn^{++}, the spectrum of the sample under study, and that of a g-marker being simultaneously recorded; the reference sample is a piece of natural blend containing Mn^{++} as an impurity and for which the g-factors of the lines used were determined, with the aid of an NMR Gaussmeter, to amount to 1.98543 and 2.02574, respectively, with an accuracy of 8×10^{-5}. In all five compounds investigated, the measured values did not show any temperature dependence between 100 and 300°K. In the case of hypoxanthine alone, a slight variation of g with the dose of x rays was noted. The results thus obtained are summarized. Analysis of the data shows all the radicals studied to be characterized by g-factors larger than that of the free electron and, further, an apparently systematic decrease from hypoxanthine to adenine. (C.H.)

43341 EXPERIMENTAL ASSAYS UPON THE DISTRIBUTION OF ^{131}I TAGGED COMPOUNDS IN NORMAL AND ISCHEMIC

CEREBRAL TISSUE. Graban, Wieslaw. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 453-63(May-June 1967). (In Polish).

The influence of the common carotid artery ligation on the distribution of inorganic iodine and ^{131}I-labeled human serum albumin in the cerebral tissue was studied. The experiments were carried out on 60 rats divided into four groups. The Groups I and II being the control groups, received the inorganic iodine (Group I) and albumin (Group II). Groups III and IV were the experimental ones with the ligated common carotid arteries. It may be stated, as a result of the performed experiment, that in the cerebral hemisphere on the side of the ligated artery, the deposition of inorganic iodine decreases, while the other hemisphere demonstrates increased deposition in comparison with the control group. In cases of ^{131}I-labeled albumin administration, the concentration of the isotope is greater on the ligated side. The results serve as addendum to the clinical observations presented in earlier publications dealing with the gamma encephalographic examinations. (auth)

43342 PROTON INDUCED RADIOACTIVITY IN PRIMATES. Benson, R. E.; Thomas, R. G.; Odland, L. T. (Radiological Health Lab., Wright-Patterson AFB, Ohio). Health Phys., 13: 1123-5(Oct. 1967).

Primates were irradiated with 700 MeV and 2.3 BeV protons. The animals received either 100 rads or 1000 rads. Whole-body γ spectrometry of the cadavers of the irradiated monkeys revealed detectable levels of ^{24}Na and ^{7}Be. Extrapolation of the data to man suggests that doses of 5 to 10 rads of high-energy protons should be detectable by whole-body counting. (auth)

43343 EFFECT OF X RADIATION AND 6-MP ON THE SECONDARY ANTIBODY RESPONSE. Jilek, M.; Sterzl, J. (Inst. of Microbiology, Prague). Folia Microbiol. (Prague), 12: 21-30(1967).

The course of the secondary response in mice and rabbits immunized with sheep red cells and treated with x rays (400 to 600 R) or 6-mercaptopurine (6-MP) during the primary or secondary immune response was studied. Irradiation or the administration of 6-MP during the primary reaction did not suppress preparation for a secondary reaction in mice, but in rabbits it did. The differences in these results are attributed to differences in metabolic activity and in the rate of recovery of the function of the lymphatic tissue in the 2 species. The secondary reaction in mice was completely inhibited if they were irradiated when the proliferation phase following the primary stimulus had ended, i.e., 6 months after primary immunization. The cause of failure of suppression of secondary reaction in mice by irradiation shortly before, simultaneously with, or 24 hr after administration of the antigen was evidently because the antigenic stimulus for activation and proliferation persisted, or the cells primarily stimulated by antigen recovered and resumed their immune function. Both explanations are reasonable but the first is the more feasible, since the second would assume the development of a delayed primary reaction. Preparation for a secondary reaction occurred even in the complete absence of a primary response. (BBB)

43344 GLYCOGEN ACCUMULATION IN MONKEY AND CAT BRAIN EXPOSED TO PROTON RADIATION. Miquel, J.; Haymaker, W. (Ames Research Center, Moffett Field, Calif.). Excerpta Med. Int. Congr. Ser., No. 100, 792-7(1966).

The effects of ionizing radiation on brain glycogen metabolism of monkeys and cats were investigated. Proton irradiation of the cerebrum and cerebellum resulted in glycogen accumulation apparently exclusively by astroglial cells. Maximal increase was observed at 24 to 48 hr after irradiation. These observations provide further support of the view that astrocytes have an essential function in carbohydrate metabolism of the brain. (IAA)

43345 LASERS AND THE EYE. Mellerio, J. (Inst. of Ophthalmology, London). Ann. Occup. Hyg., Suppl., 31-41(July 1967).

A brief description of laser light is followed by an explanation of how the ruby laser is useful to ophthalmic surgery. The interaction of laser light with tissues is discussed with particular attention to simple absorption and heating which are seen as the main factors in retinal damage. The explosive nature of pulsed laser damage is mentioned. The effects of lasers other than ruby are examined for their surgical use and value as a hazard and the criteria for determining threshold damage are considered. (auth)

43346 TRANSPORT AND ACCUMULATION OF RADIOIODINE BY THYROID GLANDS OF NORMAL MALE GUINEA PIGS. Newcomer, W. S. (Oklahoma State Univ., Stillwater). Amer. J. Physiol., 213: 771-8(Sept. 1967).

Experimental data concerning T/S (ratio of concentration of ^{131}I in thyroids to that in serum) during equilibration following single injections of propylthiouracil and ^{131}I were obtained from male guinea pigs and were compared with predictions based on an open two-compartmental model of thyroid function. Unidirectional clearance, C/m, of ^{131}I by the thyroid from the blood was 1.05 μl/mg per min in recently weaned animals and 1.76 in adult animals; exit rate constant, K_{TB}, was 0.015/min. These constants are lower than those of normal rats and mice. Data concerning dependence of T/S on serum iodide concentration indicated that K_m was 0.38 mg I-/100 ml serum. Experimental data obtained over the three hr interval when binding of radioiodide to thyroprotein was allowed were compared with predictions based on an open three-compartmental model. The fraction of thyroidal ^{131}I bound to thyroprotein, K_b, was not constant contrary to expectation from the model; K_b was 0.057/min up to 30 min and was 0.024 from one to three hr. It was estimated that approximately 50% of the ^{131}I leaves the thyroid of the guinea pig without being bound to thyroprotein. (auth)

43347 RADIOCALCIUM TURNOVER IN MAN. Anderson, J.; Tomlinson, R. W. S.; Osborn, S. B. (King's Coll. Hospital, London). Lancet, 1: 930-4(Apr. 29, 1967).

Calcium-47 metabolism was studied in 61 subjects by injection of ~20 μCi of ^{47}Ca and assay of blood, urine, and feces for 12 to 14 days. For mathematical analysis of ^{47}Ca disappearing from the blood the data were fitted to the power function: $C(t) = A \cdot t^{-\alpha} \cdot e^{-\beta t}$, where C(t) = specific activity of plasma Ca at time t after injection. The fit obtained with such a γ distribution was generally better than for two power functions. The function is continuous instead of being discontinuous, and only three parameters are required, A, α, and β. For several hours after injection the curve was very close to the power function $At^{-\alpha}$. For long times, the exponential $e^{-\beta t}$ dominated the course of the curve and appeared to influence the curve earlier in patients with bone disease. Thus, for a given subject the data relating to the specific activity of ^{47}Ca after injection could be described by these three parameters over a range of time from about three min to 10 or 15 days after injection. The values of the power and the exponential index α and β are shown. For control subjects, the mean for A was 0.01008. After five min, ^{47}Ca was shown to be returning to the plasma nearly as rapidly as it left it. The rate constant for ^{47}Ca leaving the plasma was at least 0.3 per min (per μCi in the plasma) and might be as large as two per min, corresponding respectively to about 90 and 600 mg of Ca/min. The observed rate of change of specific activity at five min indicated a net rate of decrease of only 0.05 per min (15 mg Ca/min). By five min, therefore, at least 50 atoms of ^{47}Ca returned to the plasma for every 60 that left it. (BBB)

43348 SOME EFFECTS OF RARE EARTH ELEMENTS AND YTTRIUM ON MICROBIAL GROWTH. Talburt, Dwight E. (Univ. of Southwestern Louisiana, Lafayette); Johnson, G. T. Mycologia, 59: 493-503(May-June 1967).

Effects of 7 rare earth elements (Ce, Nd, Eu, Dy, Ho, Er, Lu) and Y were studied on bacteria (Escherichia coli) and fungi (Streptomyces aureus), (Rhizopus nigricans, Saccharomyces cerevisiae, Aspergillus niger, Neurospora sitophila, and Coprinus sp.). Growth responses on gradient plates indicated that Y and the rare earth elements are generally toxic to microbial growth. Bacteria were more sensitive to these elements than the fungi. Some species of the fungi were much more sensitive than other species. Colonies of A. niger (and 3 other fungi) produce oxalic acid which combined with the rare earth elements and Y to form insoluble oxalates, an important detoxification mechanism permitting further growth. Many hyphae of filamentous fungi developed abnormal morphological appearance in the presence of Y or rare earth elements. These changes included multiple terminal branching, swelling, lateral branching, and the rupture of hyphal strands by a process similar to plasmoptysis. These elements also inhibited the production of asexual spores. A ranking in descending order of the relative toxicity of individual rare earth elements and Y to growth of 4 filamentous fungi on gradient plates generally followed the order of decreasing at. no. and increasing at. radius. (BBB)

43349 BACTERIOPHAGE LAMBDA DNA WITH DIFFERENT STRUCTURES FOUND IN INFECTED CELLS. Ogawa, Hideyuki; Tomizawa, Juni-ichi (National Inst. of Health of Japan, Tokyo). J. Mol. Biol., 23: 265-76(1967).

Breakage of DNA molecules by ^{32}P irradiation was studied. The molecules were labeled at three different activity levels: 4.3, 43, and 100 mCi/mg P. Bacteria lysogenic for phage λ were infected with the ^{32}P-labeled λ phage, and DNA was extracted after incubation for various times. Based on the sedimentation properties, the ^{32}P DNA molecules could be classified into three species depending on the mode of ^{32}P-induced breakage. The molecules of species III had the same sedimentation rate as those in phage particles in neutral or alkaline (pH 12.4) zone centrifugation. Species II, which sedimented 1.13 times faster than species III, was composed of 2 components which could be separated by alkaline zone centrifugation. One component sedimented at the same rate as a single

strand of λ DNA and the other 1.14 times faster. Those of species I sedimented 1.55 and 2.2 times faster than those of species III in neutral and alkaline zone centrifugations, respectively. The molecules of species III were in a majority only at the beginning of infection; those of species II increased shortly after infection and then decreased as those of species I increased to become the major fraction. Molecules of species I were prepared from ^{32}P-labeled λ phage with high act. They were allowed to stand for various times at 4°C and analyzed by zone centrifugation. Molecules which sediment at rates equal to those of species II or III were produced. Calculations showed that a single decay in a molecule of species I produced a molecule of species II, and a single double-strand-break produced a molecule of species III. The molecules of species I had greater stability to shear than those extracted from phage particles. It was concluded that species III was composed of linear molecules of λ DNA; species II of circular molecules in which only 1 of the polynucleotides in a molecule was covalently closed; and species I of circular molecules in which both strands were covalently closed. The process of formation of the molecules of species I and its similarity to that of T4 recombination were discussed. (BBB)

43350 THE AUTORADIOGRAPHIC DISTRIBUTION AND LOCALIZATION OF ^{45}Ca IN UNDECALCIFIED FRESH AND DEVITALIZED RAT BONE AUTOGRAFTS. Salomon, Carl D.; Ray, Robert D. (Univ. of Illinois, Chicago). J. Bone Joint Surg., 48A: 1575-84 (Dec. 1966).

The topographic distribution of radiocalcium in fresh untreated autografts and devitalized implants was compared with that in normal rat metatarsals by autoradiographs of undecalcified thin sections. The ^{45}Ca was distributed in a disseminated fashion over the entire cortex, metaphysis, and diaphysis, with concentrations in the subendosteal zone in the normal metatarsals and fresh transplants, and in the subperiosteal zone in the devitalized implants. In the epiphyseal plate, almost the entire hypertrophic cartilage zone was labeled with ^{45}Ca, a finding at variance with the distribution of calcification demonstrated by staining procedures. On the cellular level, concentrations of ^{45}Ca were observed in and around osteocytes and their lacunae. The possible significance of these findings in relation to Ca metabolism is discussed. Osteocyte remnants in the devitalized metatarsals also took up and concentrated radiocalcium. On the basis of radioisotope uptake, the only significant morphological difference between living and devitalized bone was in the subendosteal and subperiosteal accumulation of ^{45}Ca. (BBB)

43351 COLLAGEN-^{45}Ca-HPO_4 INTERACTIONS FROM THE VIEWPOINT OF AGE. Deyl, Zdenek; Rosmus, Jan (Inst. of Physiology, Prague). Exp. Gerontol., 2: 85-8 (1967).

The in vitro uptake of ^{45}Ca from saline solutions containing K_2HPO_4 by skin insoluble, neutral, and acid-soluble collagens from rats two to five days old, and from rats 20 months old was studied. Insoluble collagen prepared from young animals exhibited higher ^{45}Ca uptake than samples prepared from the old animals. No significant change was observed between ^{45}Ca uptake in the presence or absence of orthophosphate; neutral and acid-soluble collagens did not exhibit any difference in the ^{45}Ca uptake between young and old animals, but they did exhibit significant increase in ^{45}Ca uptake in the presence of orthophosphate. Lathyritic collagens, both neutral and acid-soluble, bound considerably less ^{45}Ca whether phosphate was present or not. Pepsin treatment, known to eliminate telopeptides from the collagen molecule and to solubilize insoluble collagen, resulted in a slight increase of the binding capacity of ^{45}Ca, in the absence of phosphate. On the other hand, in the presence of phosphate the increase in the affinity of pepsin-solubilized insoluble collagen towards ^{45}Ca was more marked. Results indicated that the main role in the increase in the affinity towards ^{45}Ca in young preparation in vitro was due to insoluble collagen. (BBB)

43352 THE MECHANISM OF THE FLAVIN-SENSITIZED PHOTODESTRUCTION OF INDOLEACETIC ACID. Nathanson, B.; Brody, M.; Brody, S.; Broyde, S. B. (Hunter Coll. of the City Univ. of New York). Photochem. Photobiol., 6: 177-87 (Mar. 1967).

An in vitro study was made of the flavin-sensitized uv inactivation of indoleacetic acid (IAA), primarily using riboflavin as sensitizer. The dependence of the quantum yield on reactant concentrations, pH, presence of oxygen, viscosity, temperature, KI concentration, and solvent was determined. The involvement of a limiting dark reaction was demonstrated using an intermittent light technique. The results were consistent with a mechanism involving a metastable state of riboflavin as the photochemically reactive species. The riboflavin, in the metastable state, was believed to oxidize IAA to indolealdehyde, with subsequent recovery of riboflavin by autoxidation. The maximum quantum yield of the photoinactivation of IAA was 0.71, indicating a highly efficient process, approaching 100% when energy loss due to riboflavin fluorescence was taken into account. Carotenoids and pure chlorophyll-a were found to be inactive as sensitizers. (BBB)

43353 STUDIES ON THE UPTAKE AND METABOLISM OF ^{59}Fe IN CHLOROSIS SUSCEPTIBLE AND RESISTANT GRAIN SORGHUM. Muhsi, Abu Ahmed Abdul. College Station, Tex., Texas A and M Univ., 1965. 97p.

Thesis.

Studies were made on genetically related chlorosis resistant and susceptible grain sorghum grown in soils known to produce chlorotic and non-chlorotic sorghum plants. Determinations were made on the differences in the distribution pattern of ^{59}Fe, nutrient balances and ^{59}Fe metabolites in chlorotic and non-chlorotic sorghum plants. A visual rating of chlorosis provided a means to classify the sorghum varieties into "chlorotic varieties," "intermediate chlorotic varieties," and "non-chlorotic varieties." No complete Mendelian dominance in the expression of chlorosis was demonstrated and no definite hereditary control in plant nutrition that results in chlorosis was found. A variation in potassium, sodium and phosphorus content in a chlorotic plant was detected, that is, visibly an after effect while close association in calcium and iron nutrition in the production of chlorosis was demonstrated. Soil grown plants indicated no gross variation in the distribution pattern of ^{59}Fe due to differences in varieties, chlorosis production or soils. However, a higher ^{59}Fe uptake from a non-chlorotic soil and a higher ^{59}Fe uptake by susceptible varieties was demonstrated. Plants grown in nutrient culture showed differences in distribution patterns indicating a higher iron precipitation in chlorosis susceptible varieties. There was always more deposition of ^{59}Fe precipitates in tissue of a growing chlorosis susceptible variety, which later showed a similar redistribution pattern of the ^{59}Fe, migrating possibly in vascular tissues. Actual chlorosis, however, showed no effect on the distribution patterns of ^{32}P and ^{45}Ca. A chromatographic analysis for different ^{59}Fe metabolites indicated that sorghum absorbs as one metabolite which gradually changes to a secondary metabolite in about 144 hours. This secondary metabolite is presumably an active form of iron that favors rapid green pigmentation in sorghum. An application of δ-aminolevulinic acid to the medium enhances the formation of this secondary metabolite. (Disser. Abstr.)

43354 EFFECTS OF IONIZING RADIATION ON THE STRUCTURE OF RIBONUCLEASE A. Fleisher, Martin. New York City, New York Univ., 1966. 116p.

Thesis.

The effects of gamma irradiation on aqueous solutions of ribonuclease A (RNase A) were studied using the techniques of viscometry and tritium-hydrogen interchange measurements. Studies on the molecular configuration of irradiated RNase A by means of viscometry revealed a progressive irreversible increase in the viscosity which parallels the increased radiation effect and increased inactivation. The intrinsic viscosity for samples of native RNase A was found to be 3.8, whereas, irradiated samples with 8 to 10 percent residual enzymic activity had a value of 8.7. The latter value approximates that of native enzyme in 8M urea and reflects the gross molecular disorientation of the irradiated enzyme. Dissolution of irradiated samples in 8M urea caused a further viscosity increase to 9.4, which was the maximum viscosity observed for any RNase A sample other than oxidized RNase A. The urea effect was completely reversible, as was shown in experiments in which, after the urea was removed the viscosity returned to the original value. Furthermore, there was no net change in the optical density profiles or enzymic activity of protein samples after removal of urea. The possibility was considered that, especially in highly inactivated enzyme samples, some protein aggregation might occur, and that part of the observed viscosity increase might be due to the presence of polymeric molecules. However, ultracentrifugation patterns of the most viscous of the irradiated sedimentation constant of 1.9 Svedberg units. The observed elevated viscosities were therefore attributed to intrinsic changes in the configuration of the protein molecule. Tritium-hydrogen exchange studies on irradiated samples of RNase A, carried out using Bio-Gel P-2 column fractionation, also demonstrated the progressive loss of tightly bound, slow-exchanging hydrogens with increased radiation effect. Kinetic analyses of the exchange-out data confirmed that the loss of slow-exchanging hydrogens reflected the progressive unfolding of helical structure and the loss of intramolecular side chain hydrogen bonds. The results of both the viscosity and tritium-hydrogen interchange studies are consistent with the suggestion that the aqueous irradiation effect on RNase A involves extensive disorientation of the native configuration of this molecule. The magnitude of these physical changes is such as to suggest that the inactivation of the enzyme may be largely related to the observed loss of secondary and tertiary structure. (Disser. Abstr.)

Ecology

43355 FOOD CHAINS IN FRESH WATER. Kornberg, H. A. (Pacific Northwest Lab., Richland, Washington); Davis, J. J. pp 383-418 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The fresh water community is dealt with at five trophic levels: photosynthetic plants, herbivores, carnivores, heterotrophic bacteria, fungi, and chemoautotrophic bacteria. Complexities of interspecies relations and food habits among these five trophic levels gives rise to the term food web rather than food chain. Biological and physical processes occurring in aquatic ecosystem may reduce the content of radioisotopes in the surface waters by 10 to 60%. The remaining activity is transferred through the food web. Usually members of the lower trophic levels will contain most of the total quantity of radioactive materials in the ecosystem because there is a greater biomass at these levels. The distribution of a variety of radioactive substances in aquatic systems is discussed at length. Reports of the effect of radioisotopes on aquatic life range from no effect to considerable effect. Sources of radioactivity in fresh water systems include the following: natural sources (rocks and minerals), fallout, uranium mining, atomic energy installations, and research with radioisotopes. Atomic energy installations, particularly where there are separation plants, carry on continuous surveys of the fresh water ecosystem around them for academic and prophylactic reasons. Eighty-seven references are cited. (E.R.B.)

Genetics and Cytogenetics

43356 (EUR-3499I) STUDIO DELLE CORRELAZIONI FRA LE ABERRAZIONI DEI CROMOSOMI E LA DOSE NEI SOGGETTI IRRADIATI A SCOPO TERAPEUTICO. Rapporto Annuale, Luglio 1965-Luglio 1966. (Study of the Correlations Between Chromosome Aberrations and Dose in Subjects Irradiated for Therapeutic Purpose. Annual Report, July 1965-July 1966). Biagini, C.; Brancadoro, P.; Siciliano, A. (Rome Univ. (Italy). Istituto di Radiologia). May 25, 1967. 36p. (In Italian). Dep.

Research was conducted to obtain quantitative information from the analysis of peripheral blood chromosomes of subjects exposed to part-body irradiation treatment. Groups of patients were studied before exposure and 24 to 72 hours after a single irradiation with doses varying from 10 to 1000 rad. The fragments, dicentrics, chromosome breaks, complex anomalies and the average number of breaks per anomalous cell were taken into consideration. An evaluation was also made, in the same samples, of the frequency of tetraploid as against diploid cells. The data were analyzed as a function of the skin dose and the integral dose. In spite of a high degree of variability in the data, the results show that aberrations increase with the dose, more noticeably as regards the number of fragments and the average number of breaks per anomalous cell. A study, limited to the persistence of aberrations after a given time, was also conducted on a group of patients after a complete course of radiotherapy for malignant neoplastic forms. (auth)

43357 (NYO-1979-19) QUANTITATIVE POPULATION GENETICS OF MICE UNDER IRRADIATION. Progress Report, June 1, 1966-May 31, 1967. Green, Earl L.; Roderick, Thomas H. (Jackson Lab., Bar Harbor, Maine). June 30, 1967. Contract AT(30-1)-1979. 14p. Dep. CFSTI.

Effects of irradiation of spermatogonia of several generations of mice on brain weights of succeeding generations were studied, and the results are tabulated. A computer program was used for calculating inbreeding coefficients of small populations. Differences between dose groups for changes in inbreeding coefficients related to generations of ancestral irradiation were studied. Greater mortality and lowered reproductive performance were reflected in a greater increase in inbreeding coefficients. Radioinduced changes in traits controlled by many genes were studied by measuring relative proportions of phenotypic variation determined by additive genetic factors. Possible recessive effects of gonadal irradiation were examined by using the cross-backcross system of mating. Mice are being given 100 R per day of whole-body x radiation to determine selection for radiation resistance. (H.L.W.)

43358 PROGRESS IN MUTATION BREEDING. Broertjes, Cornelis (EURATOM/ITAL, Wageningen, Ger.). EURATOM Bull., 2: 45-51(June 1967).

Methods of plant breeding are briefly reviewed and mutation breeding is compared with cross breeding. Use of mutagenic chemicals and ionizing radiations in mutation breeding are discussed. Mutation research projects that are underway at the Association Euratom/Institute for Atomic Sciences in Agriculture are summarized. Illustrations are given from work in development of new flower varieties. Applications to the development of high-yielding, disease-resistant crops are discussed. (W.E.B.)

43359 COMPARISON OF FISSION NEUTRONS AND γ-RAYS IN RESPECT TO THEIR EFFICIENCY IN INDUCING MUTATIONS IN SILKWORM GONIA. Murakami, Akio; Kondo, Sohei; Tazima, Yataro (National Inst. of Genetics, Misima, Jap.). Nippon Idengaku Zasshi, 40: 113-24(Apr. 1965).

The effectiveness of ^{235}U fission neutrons for the induction of visible recessive mutations in early and in late gonial cells of the silkworm was studied, and the results compared with those of previous reports in which 14-MeV neutrons and ^{137}Cs γ rays were used. The dose-mutation frequency curve for fission neutrons was essentially the same as that for other radiations, showing a slow rise in the lower dose range but a rapid rise in the higher dose range. Mutation response to fission neutrons was almost similar for male and female gonial cells, although higher frequencies were observed for fission neutrons than for γ rays or 14-MeV neutrons. When radiation doses producing a frequency of 10^{-3} of visible recessive egg color mutations were used as a criterion, the relative biological effectiveness of fission neutrons to γ rays was about 1.7 to 2.4 for early stage gonia and 3.0 to 4.2 for late stage gonia. Similar results were reported for 14-MeV neutrons although the values were lower. (BBB)

43360 STUDIES ON EFFECTIVE IRRADIATION TECHNIQUES TO INDUCE MUTATIONS IN RICE. Tanaka, Sachihiko; Sekiguchi, Fumihiko. Ikushugaku Zasshi, 16: 40-6(1966).

The irradiation techniques to induce mutations in rice effectively were checked using chlorophyll mutants as an indicator after acute irradiation of air-dried dormant seeds, and after chronic irradiation of developing seeds and growing buds. In acute irradiation of dormant seeds, the low mutation rate and the saturation effect of the mutations at high exposure were observed showing less effectiveness of the dormant seed irradiation. In chronic irradiation of growing plants, the mutation rate per R unit was nearly constant and neither threshold exposure nor saturation effect of the mutations was observed. In irradiation of developing seeds, only limited exposure may be delivered owing to severe radiation damage; the actual number of mutants was low in comparison with those of the developing bud irradiation. For increasing the number of the mutants in the M_2 generation, irradiation of the developing buds was the most effective; irradiation of the developing seeds was less effective; and irradiation of the dormant seeds resulted in the lowest rate of mutation. (auth)

43361 DISTANT MUTAGENIC EFFECTS OF IONISING RADIATION IN MAMMALS. Kerkis, J. J.; Jasnova, L. N. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Nature (London), 215: 1403-5(Sept. 23, 1967).

A study is described of the mutagenic effects of humoral toxic factors which appear in mammalian tissues after X-irradiation. Mice and rats were employed for the studies. In the first series of experiments mice were irradiated with X-rays (1,500 R at 30 R/min) while their heads were screened with lead, and the frequency of anaphases and telophases with bridges and fragments in the corneal cells were estimated. Under these conditions the frequency of corneal cells with chromosome aberrations increased seven times as compared with completely protected controls and ten times compared with unirradiated animals. In a second series of experiments rats and mice were irradiated, and extracts prepared from their bodies and brains and injected into other animals, from which preparations of cornea and bone marrow were made, and the number of cells with chromosomal aberrations counted. There was a significant increase in the number of cells with aberrations in animals which had been injected with extracts from the whole bodies and brains of the irradiated animals. Extracts from liver, spleen, testes, jejunum, fatty tissue and blood of irradiated animals did not produce any significant mutagenic effect. The selective mutagenic activity of the irradiated brain did not appear to be related to the chemical specificity of the cells of the central nervous system. The important part played by the metabolic processes of the whole organism in the formation of "radio-toxins" is emphasized. In a third series of experiments the mutagenic effect of saline tissue extracts from irradiated animals on the chromosomes of human leucocyte cultures was studied, the extracts being introduced almost at the end of the premitotic stage, and metaphase plates examined. When using brain extracts from irradiated mice the mutagenic effect of the extract was manifested by a 13% increase in the frequency of cells with chromosomal aberrations. All the aberrations appeared to involve chromosomal breakages at secondary constrictions and in the region of the centromere. Various hypotheses have been proposed to explain how chromosomal breakage are formed after irradiation of distant parts of the body. (UK)

43362 CHROMOSOMAL INSTABILITY IN PROGENY OF A DIPLOID MUTANT ORIGINATING FROM IRRADIATED TOMATO SEEDS. Lesley, Margaret M.; Lesley, James W. (Univ. of California, Riverside). J. Hered., 58: 72-3(1967).

After seeds of the tomato variety Homestead were immersed in a solution of ^{32}P for five days, a mutant having nonyellow skin and less pubescence occurred in R_2. Only one of 16 seeds grew after five days in the ^{32}P solution. This R_1 plant was normal except for a trace of variegation and lower fertility. Apparently, the treatment was sufficiently drastic to produce 2 independent changes in a single R_1 plant, one involving skin color, the other pubescence and fertility. The new y gene proved to be allelic to y, which is the recessive allele of y, the yellow skin gene of Homestead, and is therefore in chromosome 1. The y mutant was less fertile and the leaves were more dissected than normal Homestead. Less pubescent, or less-pub, is recessive to the normal pubescent or pub type. A trisomic plant occurred in the F_2 from a normal diploid X mutant mating. This plant and its trivalent at pachytene both resembled triplo-7. Evidently two chromosomes were involved in the original mutation. The weak association of one pair of chromosomes may account for the origin of the trisomic and of the tetraploid branch. Trisomics occur rarely in the tomato, either spontaneously or after ionizing radiation. They are perhaps due to previous alterations of a chromosome, such as a deficiency, duplication, or inversion that interferes with close pairing in meiosis. (BBB)

43363 A COMPARISON BY MEANS OF X-IRRADIATION IN AIR AND IN OXYGEN OF THE SUPPRESSOR-ERUPT SYSTEMS IN SEVERAL STRAINS OF DROSOPHILA MELANOGASTER. Aubele, Audrey Marie. Columbus, Ohio, Ohio State Univ., 1966. 99p.

Thesis.

A specific suppressor system, the suppressor-erupt—erupt, was analyzed in several strains of Drosophila melanogaster. Embryos of three parent strains (Su-er tu bw; er^+ $su\text{-}tu^+$ strain, the al b Su-er^+ c tu^+ sp^2; er^+ $su\text{-}tu^+$ strain, and the Su-er tu bw; st er su-tu or suppressor-erupt strain) and seven strains derived from them by chromosome substitution were exposed to x irradiation in air and in 100% oxygen at 12 ± 12 hr of embryonic development. The supposed normal wild-type, non-effective alleles (er^+) in the third chromosomes of the Su-er tu bw; er^+ $su\text{-}tu^+$ strain and in the al b Su-er^+ c tu^+ sp^2; er^+ $su\text{-}tu^+$ strain are effective erupt alleles, although of lower penetrance and expressivity than the mutant er allele present in the suppressor-erupt strain. The Su-er^+ allele in the second chromosome of the al b Su-er^+ c tu^+ sp^2; er^+ $su\text{-}tu^+$ strain is an effective suppressor of the third chromosome er^+ allele present in the third chromosome of this strain, and is equally effective against the er^+ allele present in the third chromosome of the Su-er tu bw; er^+ $su\text{-}tu^+$ strain. There is no significant difference between the frequencies of total erupt produced after x irradiation in the suppressor-erupt strain used in this investigation and those found originally in earlier studies on this strain. A decrease in the expressivity of the suppressor-erupt system in the suppressor-erupt strain may be indicated by the lower frequency of extreme erupt out of the total erupt class which was obtained in the present study of this strain. Differences in penetrance and expressivity, particularly after x irradiation in 100% oxygen, obtained in the Su-er tu bw; er^+ $su\text{-}tu^+$ strain and in the al b Su-er^+ c tu^+ sp^2; er^+ $su\text{-}tu^+$ strain after replacement of their respective second chromosomes by the second chromosome of the suppressor-erupt strain indicate some change between the original suppressor-erupt second chromosome and that now present in the Su-er^+ tu bw; er^+ $su\text{-}tu^+$ strain. Additional modifiers on the X chromosome of the Su-er tu bw; er^+ $su\text{-}tu^+$ strain which act to enhance suppression of the erupt response are also suggested by results obtained with several substitution strains. Action of x rays by direct enhancement of the effect of the erupt alleles is not supported from the results obtained in this investigation, since the penetrance and expressivity of the er^+ allele after x irradiation differed among substitution strains having the same er^+ allele together with different suppressor of erupt alleles in the second chromosome. The major action of x rays in producing the erupt phenotype appears to be an interference with the action of the suppressor of erupt associated with any given er or er^+ allele. The presence of oxygen during irradiation exerts a differentiating effect on the expression of erupt in the various strains tested. Combinations of second and third chromosomes with the same levels of extreme and total erupt after x irradiation in air were found to differ from each other after x irradiation in 100% oxygen. (auth)

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Refer also to abstracts 43055–43057, 43218, 43277, 43288, 43292, 43324, 44146, and 44894.

43364 (AD-645002) RADIATION ENVIRONMENT SYSTEM (RADIO-FREQUENCY TYPE). Final Report. McCurnin, T. W.; Perper, L. J.; Battistelli, J. J. (Electro Technical Analysis Corp., Tucson, Ariz.). Nov. 28, 1966. Contract N00228-66-C-1055. 127p. (USNRDL-TRC-87). CFSTI.

Findings pertinent to establishing feasibility of a system capable of simulating radiation environments using radio-frequency techniques are covered. Both radiation from initial bursts and from subsequent fallout are considered. Two basic techniques could conceivably be used as the basis for simulation, one based on electromagnetic field intensity, the other on the velocity of propagation of radio-frequency waves. Analysis reveals that systems based on electromagnetic field intensity are incapable of providing required accuracy. The required accuracy can be provided by two types of systems based on propagation velocity. Hyperbolic grid systems and direct distance measurement schemes both possess the required accuracy. For simulation purposes the hyperbolic system is preferred. A system can be derived which is capable of meeting the simulation objectives. A high degree of repeatability can be provided using methods established and proven by hyperbolic navigation systems. Requirements of the simulation allow simplification relative to existing navigation systems. (TAB)

43365 (CLOR-66/D) RELATIONSHIP BETWEEN THE $^{90}Sr/Ca$ RATIO IN THE DIET AND URINE OF POPULATION. Czosnowska, W.; Pietrzak-Flis, Z.; Grabowski, D. (Centralne Laboratorium Ochrony Radiologicznej, Warsaw (Poland)). 1967. 10p. Dep.

Ratios of $^{90}Sr/Ca$ were determined in the diet and urine samples taken from 40 teenagers in the period February 1965 to May 1966. Mean value of the $OR_{urine/food}$ value 1.03 ± 0.03 was found. A small standard error of the mean seems to indicate that by pooling urine from a large number of persons, large individual variation can be eliminated to a satisfactory degree. (auth)

43366 (CONF-670537-1) EVALUATION OF LASER HAZARDS. Sliney, David H.; Palmisano, William A. (Army Environmental Hygiene Agency, Edgewood Arsenal, Md.). [1966]. 19p.

From American Industrial Hygiene Conference, Chicago, Ill.

Recent developments in laser technology have produced greater energy and power outputs in an increasing variety of lasers of differing wavelengths. A variety of hazards exist to individuals working at or in the vicinity of laser operations. A program of hazard evaluation and control was conducted by the authors in a variety of laser installations. The principal hazards of laser radiation to the eye due to both direct and reflected viewing are discussed. Criteria for determining the hazards of a given laser are discussed by evaluating the effects of the laser output characteristics (power or energy output, wavelength, emergent beam diameter and divergence) and the effects of various environmental factors (outdoor or laboratory setting and ambient lighting). Methods of measuring or calculating the light intensity at a given point are discussed. Hazard control procedures and guidelines developed for a variety of specific types of installations are given. (auth)

43367 (NP-17029) DATA FROM RADIATION PROTECTION PROGRAMS. Volume 4, Number 2. (Department of National Health and Welfare, Ottawa (Ontario). Radiation Protection Div.). Feb. 1966. 40p. Dep. CAN.

Radiation protection guides adopted in Canada to ensure that exposure of radiation workers and of the general population will remain within acceptable limits are presented. The guides are based on the recommendations of the International Commission on Radiological Protection. Data are presented on fallout during Jan. 1966. Data are included on total β activity in air and precipitation samples and the content of ^{137}Cs and ^{90}Sr in milk samples. Analysis of urine samples from people residing in the northern part of Canada showed high levels of ^{137}Cs that were not related to the consumption of caribou or reindeer meat. Samples of seal meat were analyzed for ^{137}Cs content. The average value of ^{137}Cs in seal samples was found to be comparable to the value obtained for beef samples from local markets in Ottawa. It was concluded that the consumption of seal meat did not contribute to the high content of ^{137}Cs in the bodies of the people of North Canada. Data are included from monitoring programs in the environs of reactors in Canada during Jan. 1966. (C.H.)

43368 (NP-17040) GUIDANCE FOR THE CONTROL OF RADIATION HAZARDS IN URANIUM MINING. Report No. 8, Revised. (Federal Radiation Council, Washington, D. C.). Sept. 1967. 60p. GPO $0.40.

The control of radiation hazards in uranium mines is discussed. It is pointed out that the natural radioactive decay of U leads to the formation of various radioisotopes in ore bodies, including Rn, which is gaseous. Radon gas formed by the radioactive decay of

^{226}Ra escapes from exposed rock surfaces into the air in U mines, where it continues to decay, generating a series of radon daughters, which present a carcinogenic hazard when inhaled by miners. Most U ore is mined from sandstone that contains free silica, the causative agent of silicosis in miners. Physical hazards associated with the use of machinery, handling of materials, falls of persons, and falls of ground are comparable with those found in other mining operations. Emphasis is focused on the control of radiation hazards associated with the underground mining of U. Background material is presented for use in the development of guidance by federal agencies in regulatory programs and in programs of cooperation with states concerning radiation protection in the mining of U ore. (C.H.)

43369 (PHS-999-RH-25) RADIONUCLIDE STANDARDIZATION. A Bibliography. Coats, George I. (National Center for Radiological Health, Rockville, Md.). Apr. 1967. 38p. Public Health Service, Washington, D. C. Free.

The bibliography contains references on absolute counting (23); coincidence technique, formula and corrections (41); calibration by beta and 4 pi beta methods (89), beta-gamma coincidence (32), gamma-gamma coincidence and gamma counting (27), x-ray-gamma coincidences (17), alpha-gamma coincidence (7), liquid scintillation counters (14), ion chambers and calorimeters (9), coincidence circuits (48); dead time and statistics (32); thin films (21); sample preparations, back scattering and self-absorption (30); maintenance and storage of standards (9); intercomparison of solutions (7); and general references (12). (auth)

43370 (TID-23740) INTERCOMPARISON OF THE RELIABILITY OF BODY ^{137}Cs MEASUREMENTS ON HUMAN BEINGS. Maletskos, Constantine J.; Dean, Phillip N.; Lough, S. Allan; Miller, Charles E. (Division of Biology and Medicine (AEC), Washington, D. C.). June 6, 1967. 102p. Dep. CFSTI.

As a result of large variations in the ^{137}Cs body burdens reported by the participating laboratories, the Division of Biology and Medicine, USAEC, appointed, in 1962, an ad hoc committee to conduct an intercomparison between these laboratories on the reliability of body ^{137}Cs measurements on human beings. The intercomparison was divided into three phases; intercomparison with National Bureau of Standards ^{137}Cs sources to determine variations in the absolute activity of the laboratory standards and to place the laboratories participating in this study on a common basis for future work; determination, at three different distances from the detector, of the ratio between three ^{137}Cs sources with nominal activities of 1000, 100 and 10 nCi, i.e., between a decade set, to assess the ability of each laboratory to account for all the physical and electronic variables in measurements conducted with whole-body counters; and determination of the ^{137}Cs body burdens of two well-documented subjects (one with a normal burden and the other with a burden ~10 times as great) by the usual procedure of each laboratory to assess the reliability of calibration factors and the control of physiological and other physical variables. In view of the results and of the time it has taken to complete the study, it is not clear why the original results were so variable. Since that time, the normal ^{137}Cs burdens have increased, instrumentation has improved, a greater attention has been devoted to calibration factors, and each laboratory has gained much experience. Any and all of these factors have probably contributed to the state of the art which has been demonstrated by the intercomparison. (E.R.B.)

43371 (UR-49-837) ANALYSIS OF RADIATION DEPTH DOSE DATA. Glover, John Richard (Rochester Univ., N. Y.). 1967. Contract W-7401-eng-49. 167p. Dep. CFSTI.

Thesis.

Depth dose data from the British Journal of Radiology, Supplement Number 10, 1961, were analyzed to rectify the fact that in the seventy-two years since the discovery of x rays no single analytic method of computing central axis per cent depth dose (Pc) had been produced which had been shown to be applicable over all depths (t) from the point of maximum ionization (t_0) ($T = t - t_0$), all surface field areas (A_0), and which would apply over the entire range of focal-skin distances (FSD) and qualities of interest in radiologic physics. Two systems of equations are presented that were empirically derived which allow computation of Pc continuously for all depths and areas. An equation for the scatter contribution to central axis per cent depth dose was derived that can be used in an implementation of Clarkson's scheme for the calculation of off-axis depth dose and thus isodose curves. Two equations for tissue/air ratios (TAR) were derived. Evidence is presented which suggests that one equation may also apply to neutron-induced depth dose and that an equation similar to it may apply to transverse depth dose and to the description of the energy degradation of beams of radiation traversing absorbing media. (C.H.)

43372 DECONTAMINATING APPARATUS. Atyunin, N. Voen. Znaniya, No. 5, 26-7(1966). (In Russian).

A self-contained car-borne apparatus was designed and produced for degassing, disinfecting, and deactivating areas contaminated with agents of mass attack. It is intended for distributing special preparations warmed to 60 to 80°C and propelled by a stream of water under 4 to 5 atm of pressure. A gas-liquid apparatus mounted on a standard car, would adapt itself well to such operations. The process of decontamination is accomplished by utilizing the heat and kinetic energy of the exhaust gases and of water vapor, and the effect is improved by rubbing a contaminated surface with a waxed brush. The apparatus may also be used for sucking in contaminated dust by introducing minor equipment changes. It weighs about 14 to 16 kg, uses some 1.5 liters of liquid per sq meter, and 3 to 4 minutes are needed for mounting or dismounting. The list, dimensions, and functions of separate parts are included, and the operation is explained in some detail. (CFSTI)

43373 INVESTIGATION OF THE RADIOACTIVITY OF THE SOIL IN A REGION WITH AN ELEVATED RADIATION BACKGROUND. Mikhailov, M.; Petkov, T.; Yanichkova, M. Rentgenol. Radiol., 5: No 3, 179-87(1966).

A high γ-radiation background was found at the village Bachkovo, Plovdiv District, and in its vicinity. A comparison with measurements carried out in a control region (village Simeonovo, Sofia District) indicated that the natural radiation background at Bachkovo was 3 to 5 times higher than that at Simeonovo, which was 0 to 10N R/hr. In a location near Bachkovo, the γ-activity reached 1000N R/hr. An examination of the β-activity of soil and rocks in the region of Bachkovo was carried out. The increased radioactivity in this region could be ascribed in part to the presence of uranium minerals (otenite and torbernite) in local rocks, but this was not sufficient to account for it completely. (JPRS)

43374 ULTRASONIC DECONTAMINATION. Zlatanov, S.; Lekov, D. Voenno Med. Delo, No. 4, 53-5(1966). (In Bulgarian).

A study of ultrasonic decontamination of radioactivity is described. A UG-1 ultrasonic generator with the following characteristics was used: frequency, 22 kC; output power, 500 W; transducer, magnetostrictive. Nickel plates were contaminated with a pollution of ^{89}SrCl for a period of 24 hr. The plates were then placed in two separate decontamination baths maintained at a temperature of 40°C, immersed in a water solution containing 5% "SINPRO," a Bulgarian surface cleansing agent; and immersed in pure tap water. The ultrasonic vibrator was immersed in water, the two baths were placed on top of it and kept there from 15 min to 2 hr. A third batch of nickel plates was mechanically washed with a 5% solution of "SINPRO" and scraped with three brushes at a water temperature of 40°C for a period of five min. The first, second, and third batch of plates was decontaminated 81, 29, and 67%. These percentages were low as compared to those in existing literature (98 to 100%) and were attributed to the primitive equipment used in the study. (JPRS)

43375 NEW METHOD FOR THE QUANTITATIVE DETERMINATION OF RADIOACTIVE CONTAMINATION OF SURFACES. Mikhaylov, M.; Petkov, T. Rentgenol. Radiol., 5: 266-9(1966). (In Bulgarian).

A procedure for the quantitative determination of radioactive contamination of surfaces has been developed which is based on the method of film decontamination proposed by St. Robev et al. (Author's Cert. No. 10,757, 25 Aug. 1964). By using a polyvinyl alcohol film, 96% of the radioactive impurities contaminating a surface were removed. To form this film in the quantitative procedure for the determination of contamination, a solution prepared by heating 20 g of polyvinyl alcohol in 100 g of a 2% solution of EDTA for 10 min at 100° on a water bath under stirring is used. Ten cc of 50% alcohol and four to five drops of glycerol are added to the viscous solution. Upon application of the solution to a surface, the film forms in 20 to 30 min. A section of the film with a definite area is dissolved in water at 40 to 50°. The resulting solution is evaporated to form a thin film (5 to 6 mg/cm^2) on which measurement of the radioactivity is carried out by means of a counter. (JPRS)

43376 RADIONUCLIDES OF CERIUM, RUTHENIUM, AND ZIRCONIUM IN BLACK SEA PLANTS AND ANIMALS. Parchevskii, V. P. (Inst. of Biology of Southern Seas, Sevastopol, USSR). Okeanologiya, 5: 856-62(1965). (In Russian).

During 1961 and 1962, the total β radioactivity of certain Black Sea organisms (Padina pavonia, Cystoseira barbata, Ulva rigida, and Zostera marina) was monitored. This activity amounted to 1.8 to 23.3 pCi/g wet wt. Artificial radioactivity levels of these hydrobionts and Mytilus galloprovincialis during 1962 and 1963 were (in

pCi/g wet wt) 0.11 to 3.04 for ^{141}Ce and ^{144}Ce, 0 to 0.99 for ^{103}Ru and ^{106}Ru, and 0 to 4.48 for $^{95}Zr-^{95}Nb$. (E.R.B.)

43377 ^{210}Pb IN TOBACCO AND CIGARETTE SMOKE. Ferri, Esther S. (Public Health Service, Winchester, Mass.); Christiansen, Howard. Public Health Rep. (U. S.), 82: 828-32(Sept. 1967).

Tests of six brands of cigarettes have shown that ^{210}Pb is a component of mainstream smoke. These brands of cigarettes included two which were nonfiltered, and one each with a cellulose filter, a cellulose and charcoal filter, a cellulose and charcoal filter with the tobacco treated for the removal of tars and nicotine, and a cellulose filter with pipe tobacco. In smoke from five brands, the ^{210}Pb activity was about half the ^{210}Po activity. Compared with average levels of ^{210}Pb inhaled from air in normal breathing, the intake of ^{210}Pb from four brands of cigarettes was double the ^{210}Pb in air, and in two brands was about equal to the ^{210}Pb in air. A constant relation between levels of radioactivity, tar, and nicotine content of the smoke could not be demonstrated. Using a recent model established by the International Commission on Radiological Protection, dosages to the pulmonary compartment of the respiratory tract were calculated, for each of the six brands, for a person smoking 20 cigarettes per day. These results showed that the radiation dose to the lung from inhalation of ^{210}Pb in smoke plus the subsequent daughter ingrowth was equal to the dose from ^{210}Po in smoke. (auth)

43378 THE RADIUM AND URANIUM CONTENT IN FOOD STUFFS AND THE ACCUMULATION OF THESE ELEMENTS IN THE HUMAN TEETH. Belova, R. S.; Lunkina, Z. P. Gig. Sanit., No. 6, 48-51(June 1967). (In Russian).

Results are reported from an investigation of the radium and uranium content in food products, water, and in the teeth of the population in two districts. It was shown that radium and uranium migrate along the biological route from water and plants to the animal body and from the latter to man, accumulating in the bone tissues. The daily amount of radium and uranium entering the body in the districts investigated depended mainly on their content in the water, but in the control district depended on their content in food stuffs. (auth)

43379 THE SIGNIFICANCE OF RADIOACTIVE PARTICLES IN THE ATMOSPHERE. Tarasov, S. I.; Konstantinov, Yu. O.; Nikolaev, S. P.; Oreshina, A. F.; Smorodintseva, G. I.; Shalak, N. I.; Yaskova, V. Z. (Inst. of Radiation Hygiene, Leningrad). Gig. Sanit., No. 6, 52-6(June 1967). (In Russian).

The investigation of radioactive particles in the atmosphere from 1963 to 1965 demonstrated the existence of a certain order in their distribution as compared to global fallout and the possibility of their appearance in the ground-surface air in the vicinity of industrial sources. By means of autoradiographic analysis of histological sections radioactive particles were detected in the human lungs. The peculiar behavior of microscopic particles of cobalt-60 was studied in experimental animals. An experiment carried out using tissue cultures helped to determine the biological effect produced by radioactive particles on tissue cells, particularly the regular inhibition of mitotic activity. For further study of the biological activity of radioactive particles new methods were elaborated for fixing microscopic particles in the lungs of animals and in the zone of cellular growth in the tissue culture. (auth)

43380 ON THE INTEGRAL DOSE. Murai, Takeo (Tokyo Medical and Dental Univ.). Kokobyogakki Zasshi, 32: 331-47 (Dec. 1965). (In Japanese).

The integral dose, also called the volume dose, is the total dose of the whole irradiated tissue volume; the unit employed is gram-roentgens. The integral dose gives a significant indication of the general reaction due to the irradiation, but it is not easy to obtain accurate integral doses under different irradiation conditions. The methods for obtaining integral doses fall into four categories. A method employing a plastic scintillator-phantom is described. The properties of the plastic scintillator used in the phantom are discussed; its fluorescence generation was not energy-dependent. The fluorescence generated by the irradiation was measured as a photoelectric current, so that the integral dose was easily and accurately obtained. (NSA of Japan) (TSS)

43381 STUDIES ON THE PROBLEM OF A CORRELATION BETWEEN THE RADIONUCLIDE CONTENT OF THE BODY AND DEVELOPMENT OF SILICOSIS IN MINERS. Nicolas, R.; Muth, H.; Oberhausen, E.; Onstead, C.; Ulmer, W. (Silikose-Forschungsinstitut der Bergbau-Berufsgenossenschaft, Bochum, Ger.). pp 565-72 of Fortschr. Staublungenforsch., Ber. IV Intern. Staublungentag., Apr. 3-5, 1962, Muenster. Reploh, H.; Klosterkoetter, W. (eds.). Dinsklaken, Niederrheinische Druckerei GmbH, 1963. (In German).

The total concentrations of K, Cs, ^{40}K, and ^{137}Cs were evaluated by means of a whole-body counter in 139 coal miners and 30 former U miners from the Erzgebirge area. Some of the U miners were also actively employed in coal mining at the time of the measurements. Compared with values observed in normal controls, there were slight increases of ~4% in K content and decreases in ^{137}Cs content of ~10%, which probably were the result of dietary factors. There were similar trends in those subjects who had silicosis, but the differences were not statistically significant. The increased concentrations of ^{40}K observed were not great enough, as compared with those in nonminers, to increase the irradiation burden very much above the natural environmental burden. There was thus no evidence found to support the possibility of any additional irradiation effect that might promote the development of silicosis. (BBB)

43382 APPARATUS AND METHODS FOR PROTECTION AGAINST RADON AND ITS DECAY PRODUCTS IN MINE ATMOSPHERES. Reiter, R. (Angewandte Forschung eV, Munich). Nukleonik, 9: 359-67(May 1967). (In German).

The requirements placed on measurement technology in the determination of Rn levels in mine atmospheres are outlined. The device developed for the determination of the Rn level is based on the aerosol filter method. The principle of this device is outlined and its construction described. An example is given of its operation. Methods for decreasing the Rn concentration in mines are given. (J.S.R.)

43383 LASERS: PRACTICAL CONTROL AND PROTECTION IN EXPERIMENTAL LABORATORIES. Burch, J. M.; Gates, J. W. C. (National Physical Lab., Teddington, Eng.). Ann. Occup. Hyg., Suppl., 65-73(July 1967).

An account of the measures that were taken in a laser research laboratory to deal with the risks that the operation of lasers may entail is presented. In some circumstances, responsibility for ensuring the safety of persons not actually engaged in the work may require precautions that seriously hamper progress; a policy of strictly excluding persons not engaged in the work was found useful. Some further observations on the probable requirements for safety precautions in the future are made. (auth)

43384 ELECTRONIC ENGINEERING ASSOCIATION GUIDE TO THE SAFE USE OF LASERS. Harris, K. Dillon (Laser Associates, Iver, Eng.). Ann. Occup. Hyg., Suppl., 61-4(July 1967).

The basic requirements to be met in the safe use of lasers are outlined. Seven areas of laser application were arranged in groups according to different degrees of hazard, and the precautions necessary for protection of personnel in each group are discussed. (B.H.S.)

43385 CONTROL OF THE HAZARDS FROM LASERS. White, D. F. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Ann. Occup. Hyg., Suppl., 55-60(July 1967).

The principles involved in the protection of personnel from the hazards associated with the use of lasers are discussed. General methods for ensuring such protection are proposed that do not depend upon precise estimates of safe intensity levels. (auth)

43386 COMPUTER TECHNIQUE FOR INTRACAVITARY RADIUM DOSIMETRY. Lane, Frank W. Jr.; Shaw, Richard K.; Stibitz, George R. (Dartmouth Medical School, Hanover, N. H.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 870-7 (Aug. 1967).

A computer program is described that was developed for determining γ dose distributions around interstitial and intracavitary Ra applicators. (C.H.)

43387 AIR-CONTAMINATION CONTROL UNIT FOR THE INSTITUTE SUPERIORE DI SANITA. Missoni, Guido Ann. Ist. Super. Sanita, 1: 387-405(1965). (In Italian).

The air filtration unit of the Physics Laboratory of the Istituto Superiore di Sanita for taking air samples is described. Some data concerning air-borne radioactivity in the period September 1961 to October 1963 are reported. (auth)

43388 CALCULATION OF THE SPATIAL DISTRIBUTION OF FAST AND INTERMEDIATE NEUTRON DOSES IN A TISSUE-EQUIVALENT HUMAN PHANTOM. Zolotukhin, V. G. (Inst. of Physics and Power Engineering, Obninsk, USSR); Prokof'eva, Z. A.; Obaturov, G. M.; Keirim-Markus, I. B.; Kochetkov, O. A. pp 41-55 of STI/PUB-136. (In Russian).

The results of a Monte Carlo calculation of spatial distributions of the doses of scattered charged particles from neutrons of the following energies: 10, 7.5, 5.0, 2.5, 1.0, 0.5 MeV, 20 keV, 5 keV, and 100 eV are presented. The phantom was regarded as an infinite elliptical cylinder with semi-axes of 18 and 12 cm, arbitrarily positioned in a plane-parallel flux of monoenergetic neutrons. In the calculation, the composition of the phantom was regarded as a homogeneous mixture of hydrogen (6.15×10^{22} nuclei/cm^3). The nuclear density of oxygen actually includes nuclei of oxygen, nitrogen and carbon, since their nuclear constants are sufficiently close under the conditions considered. The method of calculation used

is based on averaging the collision contribution to the dose, as described by Snyder and Neufeld. A double distribution was calculated for the doses of scattered protons and recoil for two fixed directions of neutron flux perpendicular to the axis of the cylinder—parallel to the minor and major axes of the ellipse in the cross-section of the phantom. Results are given for each dose component and for 264 sectors formed by the intersections of 12 polar radii and 22 elliptical arcs. The distribution is obtained from these data using a Snyder and Neufeld calculation. The insignificant discrepancy is satisfactorily explained by the difference in the constants used and the different geometrical conditions. The data can also be used to calculate the absorbed neutron doses to the critical organs of man, and the average dose to the body under conditions that are closer to reality than the slab approximation. (auth)

43389 COMPARISON BETWEEN IONIZATION AND ACTIVATION METHODS FOR THE ASSESSMENT OF NEUTRON DOSES IN LIVING ORGANISMS. Broerse, J. J. (Radiobiological Institute TNO, Rijswijk, Netherlands). pp 75-84 of STI/PUB-136.

To determine the energy deposited in biological materials, different methods can be used. In experiments with neutrons produced by the D-D and the D-T reactions, activation detectors as well as ionization chambers have been used. The sulphur activation method offers the advantage of a small detector; however, the dose determination depends on a knowledge of the neutron energies and the corresponding activation cross sections. The ionization method is a more direct approach, but to obtain a sufficient sensitivity the chambers frequently have an inconveniently large volume. The experimental procedures for both methods are described. Three different gas mixtures were suggested for use as filling gases for the tissue-equivalent ionization chambers. To investigate the equivalence of these gases the response of the chambers was studied for the different gas mixtures at various neutron energies. A comparison of the two dosimetry methods was carried out by simultaneous irradiation of the sulphur pellet and the ionization chamber. For 15-MeV neutron irradiations a good agreement between both methods was obtained. However, for 3-MeV neutron irradiations, it was found that the dose calculated on the basis of the sulphur activation had to be multiplied by a factor 1.65 to obtain the correct value corresponding to the tissue-equivalent ionization chamber. The large resonances in the cross section curve for the (n,p) reaction in sulphur, in the neutron energy range from 2.5 to 4 MeV, may be responsible for the discrepancy in the doses measured with these independent methods. (auth)

43390 TOLERANCE TO THE COMBINED EFFECTS OF HYPOTHERMIA, ANOXIA, AND IONIZING RADIATION. Andjus, R. K.; Matic, Olivera; Savkovic, Nadezda (Univ. of Belgrade, Inst. of Nuclear Sciences, Belgrade). pp 159-69 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14-18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967.

See CONF-650668.

An experimental study on rats was undertaken in order to evaluate to what extent severe anoxia, made tolerable by virtue of hypothermia, may prove of protective value against lethal effects of x radiation. A protective factor approaching 3 proved to be obtainable by the combination of deep but spontaneously reversible hypothermia and a severe but easily tolerable anoxia, provoked by tracheal occlusion. Terminal respiratory movements were recorded and changes of brain ATP, ADP, AMP, creatine phosphate, and lactate levels were followed during the course of anoxia, so that degrees of protection, afforded by different phases of the post-occlusion period, could be correlated with biochemical and physiological parameters. (23 references.) (auth)

43391 CRITERIA OF RADIATION SAFETY IN PROLONGED SPACE FLIGHTS. Grigorev, Yu. G.; Kovalev, E. E.; Lebedinskii, A. V.; Nefedov, Yu. G.; Vysotskii, V. G.; Ryzhov, N. I.; Markelov, B. A.; Smirenni, L. N.; Dudkin, V. E.; Derbeneva, N. N. (Academy of Medical Sciences, Moscow). pp 185-97 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14-18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967.

See CONF-650668.

Problems involved in the protection of astronauts against space radiations are reviewed. It is concluded that there are still many obscure problems on the way to solving the problem of ensuring radiation safety during space flights. The successful realization of an astronaut's protection during the course of long-term space flights will depend, on the one hand, upon how accurately the criteria of radiation hazard will be evaluated and, on the other hand, upon how effectively the basic questions of creating a radiation safety system will be solved. Such a system includes protection, dosimetry control, prophylaxis and medical treatment of radiation injuries, the determination of biological features of the effect of space radiation in terrestrial environments and in combined action, as well as other factors of space flight. There is no doubt that only a complex approach will assist in building up all the necessary prerequisites for solving the problem as a whole. (28 references.) (C.H.)

43392 MINISTRY OF AVIATION CODE OF PRACTICE. Mendoza, A. (Ministry of Aviation, St. Mary Cray, Eng.). Ann. Occup. Hyg., Suppl., 43-6(July 1967).

A code of practice is outlined for protection of personnel using lasers. The hazards of laser radiation to organs in the body and safe working levels are established. (B.H.S.)

43393 INTRODUCTION TO LASERS. Evans, D. E. (United Kingdom Atomic Energy Authority, Culham, Eng.). Ann. Occup. Hyg., Suppl., 3-12(July 1967).

The special character of the light from a laser depends upon its brightness and its coherence. These two ideas are discussed, and it is shown that laser light is orders of magnitude brighter and at the same time much more coherent than light from any other source. The principle upon which a laser operates is explained, using the ruby laser, a 3-level fluorescent system, as an example, and the technique of Q-spoiling leading to giant pulses whose power may be measured in gigawatts, is touched upon. Rare earth lasers, which are four-level systems exemplified by the neodymium glass laser, and gas lasers of which the most common example is the helium-neon laser, are described briefly. (auth)

43394 DERIVATION OF MAXIMUM PERMISSIBLE EXPOSURES TO LASER RADIATION. Flood, J. M. (Royal Aircraft Establishment, Farnborough, Eng.). Ann. Occup. Hyg., Suppl., 47-53(July 1967).

A biological model designed for calculation of safe areas or safety contours in any laser experiment either at short ranges in the laboratory or over long ranges through the atmosphere is illustrated. The two cases of direct and indirect viewing are considered. (B.H.S.)

43395 THE RADIATION DISTRIBUTIONS AROUND LINEAR RADIUM SOURCES AS MEASURED WITH THERMOLUMINESCENCE DOSIMETRY (TLD). Lin, Fang-mei; Cameron, John R. (Univ. of Wisconsin, Madison). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 863-9(Aug. 1967).

The use of small single crystals of LiF as thermoluminescent dosimeters was demonstrated to have sufficient accuracy to map radiation distributions close to radium sources in the areas of clinical interest. Careful measurements of the radiation distributions around linear radium needles showed significant deviations from the published table values, which were based completely on mathematical calculations. Various corrections were made to the table values which resulted in better agreement with the experimental data. On the particular radium slug studied, the experimental results showed the asymmetric distribution of radium salt in the slug and the greater filtration at the eyelet end of the slug which was confirmed by a combined autoradiograph and roentgenogram. (auth)

43396 COMPUTER DOSIMETRY SYSTEM FOR RADON SEED IMPLANTS. Rose, Joseph A.; Robinson, J. Eugene; Bloedorn, Fernando G. (Univ. of Maryland, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 878-85(Aug. 1967).

A computer technique is described that was developed to calculate and plot radiation fields produced by Rn seed implants. (C.H.)

43397 THERMOLUMINESCENT MEASUREMENT OF CELLULAR RADIATION DOSE. Hendee, William R.; Kennedy, K. (Univ. of Colorado, Denver). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 886-9(Aug. 1967).

Doses in rads to cells irradiated while attached to surfaces of various culture vessels may be calculated from in-air roentgen exposures with reasonable accuracy by use of conversions measurable with especially prepared LiF thermoluminescent powder. Conversions obtained by this method compare well with those resulting from various cellular survival studies, somewhat less well with those predicted theoretically. (auth)

43398 ^{55}Fe FROM NUCLEAR FALLOUT IN THE BLOOD OF ADULTS: DOSIMETRIC IMPLICATIONS AND DEVELOPMENT OF A MODEL TO PREDICT LEVELS IN BLOOD. Wrenn, McDonald E.; Cohen, Norman (New York Univ.). Health Phys., 13: 1075-82(Oct. 1967).

The concentration of ^{55}Fe, a nuclide which decays exclusively by electron capture, was measured in the blood of adults from the New York and New Jersey area to determine present body burdens and to evaluate a model predicting concentrations in blood from

chronic exposure. Blood was taken from seventeen male and nineteen female volunteers. Samples were digested in nitric acid, the iron extracted, and subsequently electrodeposited on stainless steel discs. Stable iron was determined gravimetrically, and iron-55 was determined both by low-background proportional counting and gamma scintillation spectrometry, utilizing a 1 mm thick NaI (T1) crystal. An equation to predict body burdens was developed following the ICRP approach using the known physiological parameters of iron metabolism in humans. Average values in August of 1966 were 2.7 pCi/mg of stable iron in men and 4.1 pCi/mg in women, a difference that is significant at the P <0.05 level of confidence. These concentrations of ^{55}Fe will deliver infinity doses of 0.85 and 0.95 mrads respectively to the erythrocytes of men and women. Although exposures to adults from environmental levels of radioiron have been low, the levels present during 1965 and 1966 have offered a means to test models designed to predict human exposures from environmental data. The lack of comprehensive data on dietary intake prevented the direct use of model to predict the levels found in blood. It was possible, however, using the model, to estimate the ratio between the sexes of ^{55}Fe concentration in blood. The ratio predicted was consistent with experimental results. (auth)

43399 RADIOIODINE FALLOUT IN AUSTRALIAN SHEEP. Melick, R. (Royal Melbourne Hospital); Van Middlesworth, L. Med. J. Aust., 2: 930-2(Nov. 1966).

The thyroid ^{131}I content of Victorian lambs was followed since 1958. Nuclear tests conducted at sites in the Pacific Ocean 4500 mi from Melbourne in 1958 and 1962 resulted in large increases in ^{131}I content of these glands. The activity appeared five weeks after testing commenced. Russian tests in the Arctic 9500 mi from Melbourne in 1961 caused a slight but definite increase in ^{131}I content ~seven weeks after the first test. The radioactivity found in thyroids of Victorian sheep was much less than that found in the northern hemisphere, and was present for a much shorter time. The ^{131}I measured in thyroids from the southern hemisphere is an insensitive index of ^{131}I contamination from the northern hemisphere, but fission products with long half-lives may approach equal distribution within a few years. From January, 1959 to January, 1966 no Victorian sheep thyroid contained 100 pCi/g. During this same period in the northern hemisphere, animal thyroids contained more than 100 pCi/g for at least 12 months, and for five to seven months sheep from London and Tennessee had more than 1000 pCi/g of thyroid. (BBB)

43400 RADIOACTIVITY AND HUMAN DIET. Russell, R. Scott. New York, Pergamon Press, 1966. 561p.

Separate abstracts were prepared on all twenty-three chapters of the book. The presence of radioisotopes in aquatic and terrestrial food chains and some practical aspects of the assessment and control of radioactive contamination in the diet of man are discussed. (E.R.B.)

For abstracts of individual chapters see: 43322–43325, 43355, and 43401–43418.

43401 REMEDIAL MEASURES. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 509-18 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Mitigation of the consequences of radioactive contamination of dietary materials presents a dilemma in which social cost is pitted against the magnitude of risk from radiation. Suggested remedial actions are given for ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr. Suggestions regarding ^{131}I include administration of stable iodide to the public, reduction of the extent to which ^{131}I is secreted into milk, and removal of ^{131}I from milk. Remedial action for ^{90}Sr includes administration of stable calcium or strontium to the population, decontamination of milk, feeding of calcium to cattle, modification of the composition of human diet, reduction of the contamination to permanent pastures, and reduction of the entry of ^{90}Sr into plants from the soil. Storage of produce for several months would be an effective remedial measure for ^{89}Sr. Removal of ^{137}Cs from milk in a manner similar to ^{90}Sr removal would be effective. However, short of modification of the diet of animals, there is no practicable way to deal with ^{137}Cs in meat. (E.R.B.)

43402 ANALYTICAL METHODS. Mercer, E. R. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 489-508 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Radiochemical analysis can be divided into three main stages; initial preparation of the sample involving ashing of the sample and extraction of the radioisotopes, isolation and purification of the nuclide, measurement of the radioactivity and identification of the radioisotopes. Detailed discussion of these procedures are given for the analysis of ^{137}Cs, ^{131}I, and ^{90}Sr in samples of animal tissue, plant tissue and soils. (E.R.B.)

43403 CRITERIA FOR RADIATION PROTECTION. Loutit, J. F. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.); Russell, R. Scott. pp 27-43 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The criteria established by the International Commission on Radiological Protection for the protection of the general population from radiation exposure from a variety of sources are discussed. With regard to occupational exposure, criteria were set up for allowable doses that could be received in a 13 wk period, with special limits for persons under 18 yr. Protection criteria for exposure of the general population to uncontrollable sources included such things as mitigation of dose rate levels where the social cost is slight, and guidance regarding radiological risks at given exposure doses. Criteria for protection from controllable sources focused on the source and its regulation. The importance of monitoring systems is discussed in relation to both sources. Recommended limits of environmental exposure both of a continuous and emergency nature are listed. Criteria are also established for recommended limits of dietary contamination with regards to both total diet and individual articles of diet. (E.R.B.)

43404 RADIATION IN MAN'S ENVIRONMENT. Loutit, J. F. (Medical Research Council Radiobiological Research Unit, Harwell, Eng.); Russell, R. Scott. pp 3-26 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The relative magnitude of radiation doses from various artificial and natural sources is discussed. The major part of the radiation to which the general population has been, or will be, exposed in the foreseeable future is from natural sources. Internal contamination by radioactivity in food stuffs accounts for up to one-fourth of the dose from natural sources in some tissues. Genetically significant doses exceeding natural background by one-third are reported in countries using modern medical diagnostic techniques. The dominant man-made source of environmental contamination is worldwide fallout from nuclear weapons testing. Highest annual doses to any age group were obtained from ^{131}I in milk. The average dose of this isotope over several years was, however, only a small fraction of the natural background. The two highest annual doses to the population were from ^{90}Sr and ^{137}Cs in that order. Exposure from ^{14}C, as yet not significant because of the long half-life of ^{14}C, will cause a greater cumulative dose over very many generations. The highest recorded dose from worldwide fallout was received by Lapps and was attributed to their consumption of reindeer meat that contains an unusually high level of ^{137}Cs. With the exception of small groups accidentally exposed near nuclear weapon test sites, there was no record of any member of the population having received an exposure, from environmental contamination from man-made sources in excess of lifetime accumulations by residents of unusually high background areas. (E.R.B.)

43405 COMPOSITION OF HUMAN DIET. Hollingsworth, D. F. (Ministry of Agriculture, Fisheries and Food, London); Hobson, E. A. pp 63-83 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Information on the composition of the human diet is needed to estimate the ingestion of isotopes in food. Food consumption data are given on a worldwide basis by region and composition of diet. The accumulation of radioactive substances in tissue is often greatly influenced by the levels of stable isotopes of the same or closely related elements. In view of this fact, a study was undertaken to determine the mineral element content of the human diet. In order to assess the content of a mineral element in a diet, it is necessary to determine not only the specific food in question, but also the nutritive and non-nutritive additions to foods, food adjuncts and water. Adventitious metallic contaminants must also be considered. Specific attention is given to calcium, strontium, cesium, and iodine levels in the diet. Iron, phosphorus, sulfur, and zinc are also discussed. No account is taken of variations in biological availability of any of these elements. (42 references are cited.) (E.R.B.)

43406 NATURE OF FOOD CHAINS AND THE NUCLIDES OF MAJOR CONCERN. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 45-62 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The radioisotopes that constitute our major foodstuff contaminants are those that are freely transported through biological systems. The nature of the principle food chains and those isotopes that, because of their ease of transport through biological systems, are of major dietary concern is elucidated. The principle transfer routes of both aquatic and terrestrial food claims are discussed. Factors determining the relative biological significance of isotopes are listed, along with those isotopes of sufficient half-life to be considered hazardous as dietary contaminants.

Radioisotopes formed as a result of both fission activities and neutron capture by stable atoms are considered. Because of their prevalence in food chains, ^{131}I, ^{90}Sr, and ^{137}Cs are considered to be critical isotopes from the standpoint of dietary contamination. (E.R.B.)

43407 EFFECTS OF RADIOACTIVE SUBSTANCES ON ANIMALS AND PLANTS. Garner, R. J. (Colorado State Univ., Fort Collins. Public Health Service, Fort Collins, Colo.); Barber, D. A. pp 159-70 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The direct effects of radiation on domestic animals and on plants are discussed. The sheep and cow are of prime interest because of ingestion of large quantities of radioactively contaminated herbage during grazing. In cows, the ingestion of low levels of contaminated herbage may result in milk doses that are above acceptable limits. Regarding chronic external exposure to livestock, the limiting hazard from γ-radiation seems to be the effect on the reproductive capacity of the male. Data concerning the continuous ingestion of ^{131}I, ^{90}Sr, and ^{137}Cs by domestic animals is largely a matter of extrapolation from data on smaller animals, and indicates that product quality is affected before any long range effects on the animal are noted. Chronic and acute exposure of plants to radiation results in a range of responses in growing plants from reduced or abnormal growth and color changes, to partial or complete sterility. Variations in radiosensitivity exist between species and within a species. Radiation damage in plants is a result of induced chromosomal aberrations with DNA the probable site of primary damage. It was shown that among plants, radiosensitivity varied in direct proportion to the nuclear volume of meristamatic cells. Other factors such as ploidy, dose received during a single mitotic cycle, and external factors such as temperature also influence the radiosensitivity of a given specimen. Inhibition or stimulation of plant growth in general, or growth of a specific part of a plant can be achieved by radiation regulation of auxin synthesis. (E.R.B.)

43408 RADIOACTIVE STRONTIUM IN FOOD CHAINS: GENERAL REVIEW. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 173-87 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

In considering the transport of radioisotopes through biological materials (food chains) attention is focused on ^{90}Sr as the most important isotope with which to contend. The short half-life of ^{131}I greatly simplifies the mechanisms by which it enters diet. Cesium-137 has a half-life exceeding that of ^{90}Sr, but it is present in soil in a form in accessible to plant roots. The beta radiation effects of dietary contamination by ^{90}Sr are increased 10 fold when ^{89}Sr is present in equal quantities. Strontium-89 alone is not an important factor in dietary contamination except possibly immediately following detonation of a nuclear weapon. Strontium-90 uptake by bone depends largely on the $^{90}Sr-Ca$ ratio in both bone and diet. The direct contamination of forage crops and cereals is a very important factor in the food chain. Uptake by growing plant roots and absorption through above ground ports assures a continuous high level of ^{90}Sr contamination. In assessing relations between ^{90}Sr deposition and the level of contamination in man's diet, three types of situations are considered. (E.R.B.)

43409 DIRECT CONTAMINATION OF PLANTS WITH ^{90}Sr. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage Eng.). pp 189-211 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Mechanisms and extent of contamination of perennial pastures under conditions of continuous deposition of ^{90}Sr are discussed. Under these conditions, consideration must be given to not only the extent to which it is initially retained on herbage eaten by cattle and the rate at which it is subsequently lost from herbage due to leaching by rain and dilution by new growth, but also to the amount of subsequent absorption from the plant base. It was shown that the rate of entry of ^{90}Sr into permanent pastures can be mitigated by the application of lime and by management practices designed to reduce the mat at the plant base. Annual crops constitute a different situation than perennials mainly because the exposure time is only of short duration. Also, with the exception of leafy material eaten as salad, the plant tissues of annual crops important in human diet are relatively well protected from direct contamination. Little if any of the ^{90}Sr absorbed by leaves of annual plants is translocated to other tissues. Exceptionally high contamination levels are found, however, in cereals owing to exceptionally high retention rates in the inflorescences. The extent of direct contamination of other annual crops seems to vary directly with the exposed surface area. 37 references are cited. (E.R.B.)

43410 TRANSFER OF ^{90}Sr INTO ANIMAL PRODUCE. Comar, C. L. (Cornell Univ., Ithaca, N. Y.). pp 247-75 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The deposition of ^{90}Sr in bone, meat, and eggs, and its secretion into milk are discussed. The rate of transfer and the extent to which deposition and secretion occur are functions of the overall metabolic processes of the animal. Evidence for the metabolic activity of ^{90}Sr in the animal is obtained by analysis of the activities of stable strontium and stable calcium in the animal. Strontium-90 content is regulated by its ratio to stable Sr and Ca in the various tissues of the animal. Figures concerning ^{90}Sr content of milk vary from 0.3 to 4.0% of the dose to the animal. This variation is attributed to the amounts of alkaline earths secreted into the milk are related to the amount of milk secreted. It therefore appears more useful to discuss amounts in terms of the percentage of the ingested dose present per liter of milk rather than the total amount secreted in milk. Many chemicals were tested to determine their effect on the secretion of ^{90}Sr into milk. It was found that with the exception of calcium infusions and the addition of exfoliated vermiculite ores, none of the substances offered any practical means of reducing levels of fallout strontium that appear in milk. Seventy-eight references are cited. (E.R.B.)

43411 ^{90}Sr IN HUMAN DIET. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.); Burton, J. D. pp 277-94 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The most meaningful expression of the ^{90}Sr content in the total diet is as a ratio to calcium. Regarding sources of calcium, diets throughout the world can be divided into three types: diets in which dairy produce is the dominant source of calcium; diets in which 40% of the calcium comes from milk, 40% from vegetables, and the rest from cereals; and diets low in milk in which vegetables are the major source of calcium. Imposed upon this classification are the conditions under which deposition occurred. The effects of each of the three types of diet under each of the conditions of contamination on the uptake of ^{90}Sr by humans are discussed. Thirty references are cited. (E.R.B.)

43412 ISOTOPES OF IODINE. Garner, R. J. (Colorado State Univ., Fort Collins. Public Health Service, Fort Collins, Colo.). Russell, R. Scott. pp 297-315 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Of the eleven radioactive isotopes of iodine born of nuclear fission, only four, ^{131}I, ^{132}I, ^{133}I, and ^{135}I need be considered from the standpoint of contamination of diet. The other seven radioisotopes are either of sufficiently short half-life or low activity that their passage through the food chains is negligible. Thus, ^{131}I is the only radioisotope of iodine that constitutes a dietary hazard. Tropospheric fallout and nuclear reactor accidents are the two major cases in which ^{131}I becomes the most important radioisotope. The direct foliar contamination of plants represents the major source of entry of ^{131}I into food chains. Its relatively short half-life (8.05 d) eliminates both the indirect routes and floral contamination. Ingestion of ^{131}I by animals is followed by rapid absorption into the blood stream and concentration of the radioisotope in a number of vital organs. Significant amounts of ^{131}I are secreted into the milk where its activity reaches a peak within hours and slowly declines. A mean value of 1.5×10^{-4}% of ingested dose was given for ^{131}I content in meat of cows. Values lower than this, by a factor of 10, were found in chickens. Values of from 5 to 8% of ingested dose were recorded for ^{131}I in eggs, six days after ingestion of ^{131}I by chickens. Dietary ingestion of ^{131}I by humans varies by a factor of 100 times depending on whether animals are feeding on growing crops (summer) or feeding on stored foods (winter). In order of importance as sources of ^{131}I in human diet, spinach ranks highest followed by milk, eggs, and meat. Milk ranks highest where it is a major food item and where cattle are grazed. Fifty-five references are cited. (E.R.B.)

43413 ^{137}Cs. Fredriksson, L. (Royal Agricultural College, Uppsala); Garner, R. J.; Russell, R. Scott. pp 317-52 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Ranking second only to ^{90}Sr, ^{137}Cs is the long-lived fission product of fallout from which man has received the largest tissue doses. Its high volatility and ease of transport in biological systems makes it a potential cause of genetic as well as somatic injury. Relations exist between cesium and potassium, but the proportionalities established for calcium and strontium cannot be established in this case. Generally, tissues that concentrate potassium also concentrate cesium, but the absolute content of potassium rather than the ratio of potassium to cesium, determines the extent to which cesium is concentrated by a tissue. The nature of the soil constitutes the greatest factor in determining the extent to which ^{137}Cs is taken up by the roots of plants. Since ^{137}Cs is readily translocated throughout the plant, foliar contamination cannot be disregarded as a source of contamination in vegetable crops. In

animals, the transfer of ^{137}Cs into edible tissues occurs quite readily. Secretion of ^{137}Cs into milk occurs within 10 min of ingestion, peaks at 5 to 10% of the ingested dose within 48 hr, and gradually declines over a period of weeks. Chickens transfer from 2.3 to 3.3% of ingested dose of ^{137}Cs into eggs. Whole-body counting techniques facilitate the detection and measurement of ^{137}Cs in humans. No significant differences exist between children and adults presumably owing to the much shorter biological half-life of ^{137}Cs in children. (93 references are cited.) (E.R.B.)

43414 OTHER FISSION PRODUCTS, INDUCED ACTIVITIES, AND FISSILE MATERIALS. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 353-63 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

Although ^{90}Sr, ^{137}Cs, and ^{131}I are the three radioisotopes of most concern to us now, we cannot neglect other radioisotopes that, in the event of an industrial accident, may become important contaminants of foodstuffs. These radioisotopes may be classified into three groups: fission products, induced activities, and fissile materials. Included among the fission products of potential importance are ^{140}Ba, ^{103}Ru, ^{106}Ru, ^{95}Zr, ^{144}Ce, ^{132}Te, and ^{131}Te. Each has been detected to varying degrees in foodstuffs, but none of them has as yet been considered a dietary hazard. The radioisotopes of induced activity include: ^{65}Zn, ^{54}Mn, ^{55}Fe, ^{32}P, and ^{35}S. These isotopes have sufficiently long half-lives to constitute a potential hazard, but their low radioactivity consigns them to this category of secondary importance. The fissile (fissionable) materials include the various ionic forms of ^{239}Pu. Its long half-life combined with the fact that it is among the most hazardous of isotopes, encouraged much inquiry into its behavior in soil over long periods of time. Studies have indicated however, that it is not readily taken up by plants and it is absorbed to only a very small extent from the gastrointestinal tracts of animals. (35 references are cited.) (E.R.B.)

43415 NATURALLY OCCURRING RADIOACTIVE SUBSTANCES: THE URANIUM AND THORIUM SERIES. Russell, R. Scott; Smith, K. A. (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 365-79 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

With the exception of ^{40}K, the uranium and thorium series are the only important naturally occurring sources of internal radiation. The isotopes of radium and their decay products are especially important. Less than half of the members of the two series are of sufficient half-life to be considered as major sources of dietary contamination. Radium, as an alkaline earth, has many characteristics in common with calcium and strontium, thus the isotopes ^{228}Ra, ^{226}Ra, and ^{224}Ra have attracted considerable attention. Small but sometimes significant quantities of radium are taken up from the soil by plant roots, but movement through the plant is virtually negligible; the concentration of calcium in the plant influences radium concentrations. Radium, like strontium and calcium, is deposited mainly in bone with only 20% of dose appearing in other tissues of the animal. Its secretion into milk is extremely small. Dietary values for radium vary widely throughout the world owing to wide differences in natural distribution in the soil. Estimates of the average daily intake from all foodstuffs in Germany, U.K., and U.S.A. range from 1 to 3%/kg. Water with a high natural radium content contributes appreciably to the total daily count in humans, especially where treatment of water and softeners are inadequate. The average radiation dose to bone from radium and its decay products is about one-tenth of the total natural background; to other tissues, about one-hundredth. The major source of radon to animals is inhalation; drinking water ranks highest as the radon source in some areas. Foodstuffs contribute negligibly to the total exposure. Lead and polonium, because of general metabolic indifference, play a minor role in diet. Plants absorb lead but do not utilize it. Toxicity to animals from high lead content in plants has been noted. Doses to man average about one-fourth that of radium isotopes. (E.R.B.)

43416 FOOD CHAINS IN THE SEA. Chipman, Walter A. (International Atomic Energy Agency). pp 419-53 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The ocean is discussed as an environment with reference to its geographical features, chemical composition, water movements and mixing, and the distribution of marine life. The food web is discussed at three trophic levels: plants, herbivores, and carnivores. Radioactive contamination of the sea arises from such sources as nuclear weapons testing, reactor installations, and radiochemical processing plants. The most abundant fission product of radioactive contamination in the sea is ^{106}Ru. Both ^{90}Sr and ^{137}Cs play an important role in contamination of marine food sources by fission products. Neutron-induced isotopes of zinc, iron, cobalt, and manganese contribute significantly to the radioactive contamination of marine biota. Based on percentage of total radioactivity, changing patterns of accumulation were noted at all trophic levels in a survey of the Eniwetok Proving Grounds in 1958. Of the total radioactivity in seawater, 52% was accounted for by the isotopes of ruthenium, zirconium and uranium. In plankton, 43% of the total activity was attributed to isotopes of cobalt. In the omnivores (flying fish), 81.3% of the activity in the liver was due to ^{59}Fe and ^{55}Fe, 58.8% of the activity in white muscle was due to ^{65}Zn. In carnivores (tuna), 90.4, 78.5 and 87.1% of activity in white muscle, liver, and dark muscle respectively was due to ^{65}Zn. The variations at different trophic levels were attributed to differences in the metabolic needs for these elements among members of the different trophic levels. Sixty-seven references are cited. (E.R.B.)

43417 POSSIBLE RELATIONSHIPS BETWEEN THE DEPOSITION OF FISSION PRODUCTS AND LEVELS OF DIETARY CONTAMINATION. Burton, J. D. (Univ. of Southampton, Eng.); Garner, R. J.; Russell, R. Scott. pp 457-67 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

These relationships differ greatly depending on whether fission products are deposited over a short period only or over a continuous period. Only the isotopes ^{131}I, ^{89}Sr, ^{90}Sr, and ^{137}Cs are considered because they would probably be the critical isotopes in the event of high exposure. Following a single deposition of fallout, the concentrations of these four isotopes in milk over a thirty day period was studied. Iodine-131 decreased steadily from day one while the concentration of the other three increased three to fivefold. Under conditions of continuous release, ^{131}I and ^{89}Sr because of their short half-lives, would accumulate only 0.2 μCi and 0.03 $\mu Ci/1\ \mu Ci/m^2$ of pasture deposition respectively. Rate factors for ^{90}Sr and ^{137}Cs are four and twenty times higher than ^{131}I respectively under the same conditions. Rates of transfer of soluble fission products to components of the diet other than milk, estimations of the total content of radioactivity in the mixed diet from levels in individual foods, effects of the physical form of fallout on the entry of fission products into food chains, and comparison of doses from external and internal irradiation after the deposition of fresh mixed fission products are also discussed. (E.R.B.)

43418 SURVEYS OF RADIOACTIVITY IN HUMAN DIET. Russell, R. Scott (Agricultural Research Council Radiobiological Lab., Wantage, Eng.). pp 469-87 of Radioactivity and Human Diet. Russell, R. Scott (ed.). New York, Pergamon Press, 1966.

The five types of dietary surveys conducted are emergency surveys in the environs of nuclear reactors, localized surveys of dietary contamination from fallout, surveillance surveys in the environs of nuclear reactors, surveys designed to provide information on food chain mechanisms, and widespread surveys of dietary contamination from fallout. Procedures involved in the planning of a survey should include establishment of proper public relations, identification of the critical radioisotopes, insurance of accuracy in the collection and interpretation of data, and provisions for the utilization of alternate sources of information. In selecting the materials for examination, primary attention should be given to those foods associated with the critical isotopes surveyed. The actual technique involved in the collection of samples is determined primarily by the scope of the survey undertaken. (E.R.B.)

43419 PROCEEDINGS OF THE FIRST INTERNATIONAL SYMPOSIUM ON THE DECONTAMINATION OF NUCLEAR INSTALLATIONS, HARWELL, ENGLAND, MAY 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Wells, H. (eds.). New York, Cambridge University Press, 1967. 361p. $19.50. (CONF-660520).

Separate abstracts were prepared on 22 papers. Abstracts on three papers were prepared previously and appeared in NSA Vol. 20 as numbers 26531, 27201, and 42677. (E.R.B.)

For abstracts of individual chapters see: 43420–43441.

43420 PRINCIPLES INVOLVED IN THE FORMULATION OF DECONTAMINATION REAGENTS. Ariss, B. W.; Thomas, C. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 3-10 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The results given in the paper support the view that a basic understanding of the mechanisms of contamination and decontamination will lead to the development of reagents which are particularly suitable for specific conditions. (auth)

43421 DEVELOPMENT OF A NEUTRAL DECONTAMINATING AGENT. D'Muhala, T. F. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 11-24 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

After a 1 min decay, the total activity (gross β, γ) of each irradiated sample was 500 cpm. And, after an eight day decay, there was no measurable activity. It does not appear that residual RD16F, remaining in a reactor system after decontamination, would be significantly activated by the thermal neutron flux. Long term irradiation tests including irradiation degradation studies are presently being conducted. (auth)

43422 DEVELOPMENT AND TESTING TECHNIQUES FOR RADIOACTIVE DECONTAMINATION COMPOUNDS. Newman, K. W. (Turco Products Inc., Wilmington, Calif.). pp 25-30 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

It is pointed out that the successful development of a decontaminating agent requires thorough planning of the work to be done and careful consideration of all aspects of the decontamination. The most important aspects discussed are effectiveness of decontamination, corrosion, waste disposal, and economics. The procedure normally followed in the author's laboratory in developing and testing a new decontaminating agent or process, for use in reactor systems, is described. (UK)

43423 THE DEVELOPMENT OF A TEST METHOD FOR ASSESSING THE DECONTAMINABILITY OF SURFACES. Smith, K. (Central Electricity Generating Board, London). pp 39-54 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Experimental work carried out in support of the proposed British Standard in preparation by the British Standard subcommittee NCE/5/2 is summarized. The proposed standard is intended for application to paint and other non-metallic surface coatings used in areas subject to contamination. The significance of various factors in the test method and details the evolution of a standard contaminating solution are discussed. Reference is made to the high adsorption of cerium and cobalt onto surfaces of glass and polythene containers from dilute solutions of mixed isotopes. (auth)

43424 THE USE OF COATINGS TO FACILITATE DECONTAMINATION. Ariss, B. W.; Thomas, C. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 55-64 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Aspects discussed show that the study of surface coatings has many contributions to make to improved radioactive decontamination. Permanent coatings based on paint systems are useful for providing easily decontaminable surfaces on a variety of substrates. Temporary coatings such as the barrier paints and Detex are valuable precautionary measures in ensuring efficient decontamination, the latter material being particularly suitable when liquid effluent disposal is not feasible. (auth)

43425 THE USE OF THICK BUILD SURFACE COATINGS IN RADIOACTIVE AREAS. Colclough, W. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 65-92 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Properly formulated thick build epoxide resin coatings are suitable for use in radioactive areas. The decontamination test used in these laboratories is a useful sorting out test and gives a good indication of the ease of decontamination during the early life of the coating. Thick build chlorinated rubber paints are only useful as undercoats, and care must be taken to ensure that the release of solvent from the coating is sufficient before covering with a finish coat. Decontaminating agents based on phosphoric acid and hydroxyethyl-cellulose are suitable for use on new and aged chemical resistant coatings. (auth)

43426 DECONTAMINATION DEVELOPMENT WORK AT GENERAL ATOMIC. Watkins, R. M. (General Atomic, San Diego, Calif.). pp 95-100 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Decontamination studies at General Atomic Division of General Dynamics Corporation are directed toward developing methods of cleanup of high-temperature gas-cooled reactor (HTGR) components. Restrictions on chemical decontamination procedures are imposed by a limited waste holdup capacity and designed for handling gases rather than liquids. For analysis of contamination, equipment was designed to simulate as closely as possible the primary coolant loop of the HTGR plant. Tests indicated that prolonged exposure to highly alkaline reagents was the most effective treatment for iodine deposits in the simulated HTGR system. Tests at the Peach Bottom reactor site indicated that reverse osmosis modules give a decontamination factor of over 1,000 for low-level contamination of radioactive wastes. This high decontamination factor suggests a great potential for the use of reverse osmosis membranes for canonical decontamination of low-level liquid wastes in future nuclear facilities. (E.R.B.)

43427 DECONTAMINATION OF PRESSURIZED WATER REACTORS. Ayres, J. A. (Battelle–Northwest, Richland, Washington). pp 101-2 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Reactor contamination occurs most often in the primary system, and results usually from either a defective fuel element, or activation of corrosion and wear products. The nature and extent of contamination depends to a large extent on the construction materials. Regarding faulty fuel element sources of contamination, flushing the primary system with a buffered mixture of oxalic acid and hydrogen peroxide is recommended for decontamination. This is particularly effective against uranium and uranium oxide contaminants. Isotopes of cobalt, nickel, chromium and iron are adsorbed on the oxide films found within primary systems. The only effective decontamination measure here is removal of the entire film. This is accomplished by using 9% sulfamic acid, or in the case of films on stainless steel components, treatment with alkaline permanganate solution followed by a mixture of citric and oxalic acids. (E.R.B.)

43428 THE NATURE OF CONDENSABLE FISSION PRODUCTS IN AN HTGR ENVIRONMENT. Busch, D. D. (General Atomics, San Diego, Calif.). pp 103-16 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

A diffusion-tube technique was used to determine the diffusion coefficients and partial pressures of fission products present in a simulated high-temperature gas-cooled reactor environment. The experiments were conducted in the General Atomic in-pile Loop. Diffusion coefficients for iodine and cesium were generally determined to be in the range 0.3 to 0.1 $cm^2\ s^{-1}$, depending on the temperature. Diffusion coefficients of this magnitude, in helium at 350 psia, indicated that iodine and cesium were transported in the coolant in monatomic form. Barium-140 was found to have been transported as its precursor, ^{140}Xe. Partial pressures were calculated from the total amount of each fission product deposited in the diffusion tubes. They varied little during the irradiation of the GAIL IV element. Partial pressures were approximately 2×10^{-15} atm and approximately 6×10^{-13} atm for ^{131}I and ^{137}Cs, respectively, depending upon the position in the loop at which the measurements were made. The partial pressure of ^{140}Xe, calculated from ^{140}Ba data to be approximately 2×10^{-16} atm, was essentially constant throughout the loop. The experiments provided information of value in determining the way in which surfaces are contaminated and the components likely to require decontamination in an HTGR system. With this type of knowledge, it should be possible to choose more effective reagents and to design more efficient decontamination systems. (auth)

43429 DECONTAMINATION OF PROTECTIVE COATINGS FOLLOWING A LOSS OF COOLANT ACCIDENT. Newby, B. J.; Rohde, K. L. Contract AT(10-1)-205. pp 117-28 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The performance of chemically strippable coatings was studied. From these studies it was concluded that organic protective coatings of various generic types do not decontaminate readily by simple means when they have been contaminated under loss of coolant accident conditions. The penetration of fission product iodine into the coating is certainly one source of difficulty although limited data suggest that radionuclides other than iodine are also not removed effectively by spraying with chemical reagents. For rapid decontamination of a protective coating contaminated under loss of coolant accident conditions it appears desirable to design for remote chemical stripping of an outer coat leaving the substrate protected by a permanent coating. If the sorption of iodine from the atmosphere by the coating is complete enough and adequately irreversible, this characteristic may be used as an engineered safeguard against iodine release following a reactor accident. Remote chemical stripping would give decontamination of the walls and other interior surfaces of the reactor containment building. If rapid decontamination is not required and a conventional (nonstrippable) protective coating is used, decay of the moderately short-lived isotopes like ^{131}I and ^{132}Te and washing with a moderately corrosive reagent may provide sufficient decontamination. (E.R.B.)

43430 A DESIGN APPROACH TO DECONTAMINATION FACILITIES FOR CIVIL NUCLEAR POWER STATIONS. Barber, D. (English Electric Co. Ltd., Whetstone, Eng.). pp 145-55 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The need for decontamination facilities is governed to some extent by reactor type, but it is essential to provide facilities that will permit a high degree of operational flexibility since, during the design stage of a project, it is unlikely that every eventuality can be foreseen. In order to ensure that the best selection of decontamination equipment is provided for a nuclear power station it is necessary for the design team to have ready access to detailed knowledge not only of decontamination procedures, but also of the engineering details of the components used in the reactor and its ancillaries. (auth)

43431 PLANNING ASPECTS OF THE RENOVATION OF A CONTAMINATED BOX LINE. Ariss, B. W.; Thomas, C. R. (Atomic Weapons Research Establishment, Aldermaston, Eng.). pp 156-80 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The procedure used in the renovation of a radioactively contaminated box line is presented. Contamination levels were extremely high necessitating the use of pressurized suits and simultaneous dosimetry using quartz fiber electroscope dosimeters and direct reading integrating dosimeters. The box renovation procedure involved the mechanical stripping of its protective barrier paint, thorough cleaning, and respraying with barrier paint. Personnel protection followed the ICRP recommended limits for external radiation doses. (E.R.B.)

43432 DECONTAMINATION OF EQUIPMENT AND FACILITIES AT THE KARLSRUHE NUCLEAR RESEARCH CENTRE. Krause, H.; Hepp, H.; Kienhoefer, M. (Gesellschaft fuer Kernforschung, Karlsruhe, Ger.). pp 183-8 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The Karlsruhe Nuclear Research Center's facility for the decontamination of equipment and its installations was successful in the decontamination operations carried out so far. The value of the material which could be used again owing to decontamination was considerably higher than the operating expenses. After the new facility has started operation it will be possible to clean large, alpha-contaminated equipment also, so that we will be able to meet all requirements of the Nuclear Research Center. (auth)

43433 THE DECONTAMINATION SERVICES AND OPERATIONAL EXPERIENCES AT A.E.R.E., HARWELL. Clare, G. W.; Godfrey, R. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 189-98 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Based on annual cost of operation the Decontamination Center can obviously be rated as a sound financial investment. From an operational point of view there have been minor changes and alterations to meet changing conditions. However, if a new Decontamination Center was being designed today, there would be no major alteration in layout and design. Greater attention would be paid to crane design and reliability, more efficient ventilation and extracts, and probably lower standards of flooring materials in certain areas. The layout and spacious appearance of the Center has made for pleasant working conditions. The general impression of those concerned is that the Decontamination Center will be an asset to Harwell for many years to come. (auth)

43434 PHYSICO-CHEMICAL METHODS OF DECONTAMINATION: EVALUATION OF SOME PROCEDURES AND PRACTICES FOLLOWED IN ATOMIC ENERGY ESTABLISHMENT, TROMBAY, INDIA. Amalraj, R. V.; Kharbanda, J. L.; Siriah, H. N.; Ramaswamy, V. (Atomic Energy Establishment, Trombay, India). pp 199-211 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The safe and economic operation of nuclear laboratories, plants, and reactors is determined to some extent by the efficiency of the decontamination processes employed. Pilot plant studies on contamination and decontamination methods carried out by the Atomic Energy Establishment Trombay are reported. Radioactive contamination may be caused by adsorption and anomalous plating, electrostatic forces and/or unsaturated physical forces, exchange processes, and chemical reaction or precipitation. Factors affecting the extent of surface contamination include: porosity, roughness, and chemical reactivity of the surface, as well as the chemical nature and concentration of contaminants, contact time, and temperature. Selection of decontamination procedures depends largely on the nature of the material to be decontaminated and the chemical composition of the contaminants. Results concerning the contamination and decontamination of protective articles made of cotton, plastic, and rubber are included. Also included are data on the decontamination of stainless steel, aluminum, and mild steel surfaces. The most effective decontamination solutions tested were those containing mixtures of synthetic detergents, EDTA, or mildly corrosive agents. Electrolytic and ultrasonic methods for decontamination of metal surfaces are discussed. (E.R.B.)

43435 DECONTAMINATION AS A NAVAL PROBLEM. Wilson, R. B. (Admiralty Research Lab., Teddington, Eng.). pp 237-42 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The combination of a pre-wetting system and the foam decontaminant enable the removal of a large proportion of any contamination likely to impinge on the surfaces of a ship. The foam decontaminant satisfies all the required conditions and although developed initially as a military requirement, does appear to have certain non military applications where for any reason large scale decontamination methods have to be adopted. (auth)

43436 EXPERIENCE IN THE DECONTAMINATION OF HIGHLY ACTIVE CELLS IN THE MATERIALS TESTING REACTOR FUEL ELEMENT REPROCESSING PLANT AT THE DOUNREAY EXPERIMENTAL REACTOR ESTABLISHMENT, U.K.A.E.A. Wallace, I. G. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 243-9 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The operation of the Materials Testing Reactor Fuel Element Reprocessing Plant in Dounreay is described. The plant consists of: a pond where fuel elements are reduced to a form suitable for charging to the dissolver; two highly active cells in which the fuel is dissolved and processed through one cycle of solvent extraction; and a medium active cell where the fuel is further purified in a second solvent extraction unit. The reduction in time required results from the use of more effective decontaminating agents, knowledge of where persistent high radiation levels occur, and the use of local shielding to make access to elements at higher radiation levels. Decontaminating solutions are mixtures of various strength corrosive agents. Corrosion of the elements themselves is avoided by careful temperature regulation. Recommendations are given for improvements in the decontamination vessels. (E.R.B.)

43437 SOME APPLICATIONS OF ELECTRODEPLATING TECHNIQUES FOR DECONTAMINATING METAL SURFACES. Matthews, G. (United Kingdom Atomic Energy Authority, Windscale, Eng.). pp 250-60 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The electrodeplating method has applications where it is superior to the more conventional soaking and scrubbing processes. There are limitations, however, and in considering the application each case must be judged on its merits. In general, metals decontaminate well, where the radiometric material is accessible to the surface and not contained in crevices, or embedded below the surface. (auth)

43438 U.S. ARMY NUCLEAR DEFENSE LABORATORY'S RADIOLOGICAL DECONTAMINATION AND WASTE DISPOSAL RESEARCH: STATE-OF-THE-ART AND FUTURE PROBLEMS. Maloney, Joseph C.; Lachapelle, David G.; Tarbox, James L.; Bloore, Ernest W. (Army Lab., Edgewood Arsenal, Md.). pp 261-71 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

Methods for decontamination of military installations under cold weather conditions are discussed. Of the methods discussed, snow removal methods are the most effective. The waste disposal problem at military nuclear reactor sites is also discussed. Large quantities of radioactive liquid wastes must be disposed of and techniques for accomplishing this are the object of current research. A vertical wiped-film evaporator was developed to reduce the large volumes of liquid waste to more manageable levels. The disposal of dry combustible contaminated waste is most economically handled by packaging and burial rather than incineration owing to the high cost and difficulty of cleaning the off-gases resulting from incineration. Development of an incinerator containing efficient off-gas purifying facilities is underway. (E.R.B.)

43439 CONTROL OF DOSE TO SKIN EXPOSED TO EXTERNAL SOURCES. Wheatley, B. M.; Cole, J. S. (Central Electricity Generating Board, Berkeley, Eng.). pp 299-310 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The factors affecting skin dose are so complex that monitoring can only lead to approximate estimates. In order to determine realistic degrees of caution the beta components of radiation fields around various sources of irradiated uranium were calculated. This leads to data from which the effects of irradiation parameters and cooling times may be noted. The approximate ratio between beta dose rate and gamma exposure rate was also derived to provide guidance when only one of them is measured. (auth)

43440 OPERATIONAL HEALTH PHYSICS PROBLEMS IN A DECONTAMINATION CENTER. Clayton, R. F. (Atomic Energy Research Establishment, Harwell, Eng.). pp 311-18 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The types of problems encountered in a decontamination center are discussed. These include: design of decontamination installations; protection against airborne hazards; protection against external radiation hazards, control of surface contamination hazards; protection against criticality accidents; and documentation of contaminated articles. Although basic problems of radiological protection are always the same, each problem must be dealt with separately because the method of presentation and occurrence of the problem varies in each case. (E.R.B.)

43441 ASPECTS OF THE ABANDONMENT AND CLEARANCE OF LOW POWER NUCLEAR REACTOR SITES. Jackson, E. W.; Seager, C. (Ministry of Power, London). pp 319-41 of Proceedings of the First International Symposium on the Decontamination of Nuclear Installations, Harwell, England, May 4–6, 1966. Blythe, H. J.; Catherall, A.; Cook, A.; Well, H. (eds.). New York, Cambridge University Press, 1967.

See CONF-660520.

The legal and procedural aspects of the termination of absolute responsibility for a licensed nuclear site are discussed. Factors envolved in the clearance and decontamination of the site are included. In Great Britain, nuclear reactor sites rather than installations are licensed, and criteria regarding the legal aspects not only of operation but also of abandonment are established by the Nuclear Installation Act of 1965. Legally, the licensee is responsible, in the event of nuclear site abandonment, for complete and absolute clearance of debris and for insurance of residual radiation levels below established criteria. Until both criteria are met, the licensee may not terminate his contract for the site. Maximum acceptable radiation levels are determined by the criteria established by I.C.R.P. These criteria regulate classification of workers, permissible radiation doses, maximum contamination levels, maximum airborne contamination, and disposal of radioactive wastes. A nuclear reactor site licensee may, upon abandonment of a site, surrender his license, but termination of his period of responsibility is contingent upon the satisfaction of the above criteria. (E.R.B.)

43442 SHOWER INSTALLATION WITH MIXING DEVICE FOR THE RADIOACTIVE DECONTAMINATION OF RECUMBENT WOUNDED PERSONS. Francais, Etat. French Patent 1,280,780, Nov. 27, 1961. Filed Nov. 25, 1960.

A shower installation is described with two parallel rows of shower heads, both rows being fed from the same source of warm water. One of said rows is provided with a mixing device in which an adjustable quantity of a decontaminating solution can be aspirated by the stream of water. (auth)

43443 RISKS TO THE POPULATION AND THE INDIVIDUAL FROM IODINE RELEASES. Beattie, J. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). 8p. (CONF-670402-3(App.)). DTIE.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna.

The risk of releasing iodine from a reactor in or near a populated area is evaluated. The total number of cases of thyroid cancer likely to arise in the populated area is assessed, and the risk to any individual living near the reactor is determined. (L.C.L.)

Medicine

Refer also to abstracts 43502 and 43503.

43444 (AGARD-CP-11) LOSS OF VISION FROM HIGH INTENSITY LIGHT. (Advisory Group for Aerospace Research and Development, Paris (France)). 1966. 261p. (CONF-660339-).

From Aerospace Medical Panel Symposium of AGARD–NATO, Paris, France.

Two cases of chorioretinal burns occurred during Operation Fish Bowl. These occurred on Johnson Island during a high altitude, night time, long range, missile-delivered thermonuclear detonation. These two men were examined within the first 24 to 28 hours after the injury was sustained and were followed at less frequent intervals since that time. The exact size and location of such retinal damage within a fraction of a millimeter is essential as a basis for prognosis in regard to the final visual outcome. (auth)

43445 (COO-1485-12) ENGEBI RATS: ANOTHER CHAPTER. Jackson, William B. (Bowling Green State Univ., Ohio). May 15, 1967. Contract AT(11-1)-1485. 16p. (CONF-670503-24). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

The story of rats at Eniwetok and their ability to survive atomic detonations and inhabit areas with high levels of radiation has always focused on Engebi islet. The most available source of information has been the book, Proving Ground (Hines, 1962), which was in turn derived from reports of the Laboratory of Radiation Biology (LRB), University of Washington, as well as from other laboratory and government sources. References to Eniwetok rats have appeared in various documents in the last few years (Hines, 1966; French, 1965; Woodbury, 1962); all are to some degree incomplete or in error. The purpose of this paper is to pull together the fragments of data that are available and, at this late date, attempt to piece together the Engebi rat story. (auth)

43446 (TT-67-56008/2) POLISH MEDICAL JOURNAL. Translation of Pol. Med. J., 6: 291-536(1967). 250p. CFSTI.

A separate abstract was prepared on one paper. Thirty-two additional papers discuss various aspects of basic research, diagnosis, technology, and therapy of interest to the medical profession. (E.R.B.)

For an abstract of the individual chapter see: 43500.

43447 COMBINED EFFECTS OF STEROID HORMONES AND ^{60}Co γ IRRADIATION ON THE GROWTH OF HeLa CELLS. Oyoshi,

Shigeo (Kyushu Univ., Fukuoka). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 13: 155-6(Apr. 1966).

HeLa cells were cultured in LYT medium (Tyrode's solution 79.4%, lactalbumin hydrolysate 0.5%, and yeast extract 0.1% and bovine serum 20%). Effects of several steroid hormones and ^{60}Co irradiation on HeLa cells were estimated from the multiplication rate and morphological changes in the cells. Irradiation was performed on the second day of cultivation. The first group of cells was cultured in a medium containing steroid hormones for the first seven days. The second group of cells was grown in the same medium for seven days after the irradiation. With the addition of estrogens at low concentration before irradiation, radiosensitivity of HeLa cells appeared to be increased; treatment with estrogens after irradiation showed little effect. After exposure to higher concentrations of estradiol (50 μg/ml), irradiation destroyed the cells. The combined effects of irradiation and steroid hormones, such as progesterone and testosterone, were greater than that of irradiation alone. Treatment with these steroid hormones before irradiation was more effective than that after irradiation. Cortisone did not increase the radiosensitivity of HeLa cells at the concentrations examined. The multiplication rate and morphologic changes of cells appeared to be interdependent. (BBB)

43448 EFFECT OF BARBITAL ON MORTALITY OF MICE AFTER WHOLE-BODY X IRRADIATION. Finck, W.; Klinger, W.; Leibe, H. (Friedrich-Schiller-Univ., Jena, Ger.). Acta Biol. Med. Ger., 17: 598-602(1966). (In German).

The effect of preliminary or subsequent treatment with barbital on mortality and survival time of mice following whole-body x irradiation is described. Three injections of 150 mg of Na barbital/Kg body weight at daily intervals and irradiation with 500 R six hours after the last injection increased mortality and shortened survival time, compared with irradiation alone. Subsequent barbital treatment at the same doses, with the first injection two hours after irradiation, reduced mortality and prolonged survival time. After 1500 R neither preliminary nor subsequent barbital treatment produced any effect on mortality or survival time. A correlation between the protective action of barbital posttreatment and the induction of ascorbic acid synthesis was proposed as a possible explanation for the observed results. (BBB)

43449 EXPERIMENTS ON PHARMACOLOGICAL PROTECTION AGAINST RADIATION. I. Petkov, V. Voenno Med. Delo, 21: No 4, 31-4(Aug. 1966).

To mice subjected to a single irradiation with γ-rays in a dose of 500 R, the following drugs in the total doses indicated were administered daily per os by means of a syringe for a period beginning 10 days before (3 days before in the case of cortisone) and ending 30 days after irradiation: centrophenoxene, 250 mg/kg(I); Panax Ginseng in the form of a water-soluble powdered extract, 500 mg/kg (II); metacyl, 20 mg/kg (III); 0.5 ml/kg of an alcohol extract of Leuzea carthamoides redissolved in water (IV); cortisone, 25 mg/kg (V); a combination of centrophenoxene, cortisone, and metacyl in the total doses of these drugs indicated above (VI). The number of mice that survived on the 30th day after irradiation per 15 mice irradiated was 5, 8, 8, 12, 10, and 0 on administration of I, II, III, IV, V, and VI, respectively as compared with 5 to 7 for control mice to which only water was administered. The high protective effect of IV may be ascribed to its stimulating effect on the cerebral cortex. The harmful effect of VI was presumably due to flooding of the organism with glycocorticosteroids and consequent depression of immunological reactions exerting a protective effect. (JPRS)

43450 EFFECT OF HETEROLOGOUS ERYTHROCYTE ANTIGENS ON IRRADIATED ANIMALS. Nedyalkova, M.; Doychinova, N. Rentgenol. Radiol., 5: 225-9(1966). (In Bulgarian).

Guinea pigs were immunized by intraperitoneal injection of a suspension of human erythrocytes and irradiated on the seventh day after the injection with x-rays at a dose of 340 R. Immunization with heterologous erythrocyte antigens increased the immunological reactivity of the experimental animals as compared with control animals that were irradiated without having been immunized, but did not affect the course of the radiation sickness as such. None of the experimental animals developed complications due to infection, while one of the control animals exhibited bacteremia on the seventh day after irradiation. Aerobacter aerogenes was isolated from the blood of this animal. (JPRS)

43451 CHANGES IN THE SKIN IN THE REGION OF REPEATED BURNS IN ANIMALS EXPOSED TO IONIZING RADIATION. Maysyuk, A. P.; Komendatova, A. L.; Botsmanov, K. V. Eksp. Khir. Anesteziol., 11: No. 5, 74-5(Sept.-Oct. 1966). (In Russian).

Healing of burn injuries in 20 dogs was studied. All dogs received initial burns of second and third degree over 10% of the body, and 16 of them received doses of 400 or 600 R of ionizing radiation. All dogs received a subsequent burn without irradiation at various intervals after the original burn. A combination of second and third degree burns with ionizing radiation results in subsequent prolonged trophic disorders of tissues and changes in the mechanisms regulating regenerative processes. The external manifestations of these processes are the development of hyperplasia of the epithelium, the appearance of hyperkeratosis and papillomas, and the formation of coarse strands and nodes of connective tissue in the skin after the second burn. (JPRS) (TSS)

43452 INVESTIGATION OF THE OXYGEN CONDITION IN THE BRAIN TISSUE OF ALBINO RATS AFTER INJECTION OF RADIOPROTECTIVE AGENTS. Strelkov, R. B.; Vorob'ev, O. Ya. (Inst. of Experimental Pathology and Therapy, Sukhumi, USSR). Byull. Eksp. Biol. Med., 62: No. 8, 49-51(1966). (In Russian).

Experiments using polarography were carried out for studying the effect of sulfur-containing radioprotective agents, cystamine (100 mg/kg) and indolylalkylamine serotonin (20 mg/kg), on the oxygen tension in the functioning brain tissue of albino rats with implanted platinum electrodes. Cystamine reduced pO_2 in the brain tissue by 7.3%, and serotonin increased it by 15.2%. It is presumed that serotonin produces a specific effect on the metabolic processes in the brain tissue, which may be of some importance in the radioprotective mechanism of this agent. A difference was noted in the protective mechanism of agents containing sulfohydryls and those containing indolylalkylamines. (CFSTI)

43453 HEART SCANS WITH ^{131}Cs. Kakei, Hirotake; Uchiyama, Gyo (Univ. of Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1502-7(Feb. 1967). (In Japanese).

A technique for the demonstration of the myocardium with ^{131}Cs was developed. The technique allows visualization of the outlines of ischemic regions, their positions, and extent. The scan is carried out one to three hours after the intravenous administration of 0.6 to 1.0 mCi ^{131}Cs chloride. Patients are placed under the detector in the supine position and are scanned for 40 minutes. The detector is equipped with 3'' × 2'' NaI crystal and a 37 hole focusing collimator. Of 40 patients scanned, 26 were proved to have ischemic heart diseases by EKG and 14 were normal hearts. No defects in the shadows of left ventricles were shown in patients with normal hearts. Anterior and lateral infarctions showed cold spots, the areas of decreased myocardial uptake of ^{131}Cs. In cases of posterior infarctions, no remarkable changes were found. In all positive cases, the positions of cold spots proved by scanning entirely agreed with the areas predicted by EKG. (NSA of Japan)

43454 MORPHOLOGICAL CHANGES IN RADIOPROTECTED, LETHALLY IRRADIATED, AND BONE MARROW TREATED-ANIMALS. Dimitrov, L; Krustev, D. (Research Inst. of Hematology and Blood-Transfusion, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: No. 1, 77-80(1967).

The effect of radioprotectors and bone-marrow transfusion on morphological changes was studied in experiments on 351 albino rats irradiated with 800 R; 276 of the rats were treated with prophylactic agents (AET, MEA, and 5-HT) and therapeutic agents (bone marrow, antibiotics, and vitamins) after irradiation. Data on the survival rate of protected animals are presented. Mortality in rats irradiated with 800 R was 100% for an average of 7.6 days. A stabilization of restoration in the experimental animals occurred at the end of the first and during the second month, with fuller restoration at about the third and fourth months. Dystrophic changes appeared during the period after the sixth month and lasted until about the fifteenth month. It was concluded from the data that the prophylatic and therapeutic means applied did not completely prevent radiation injuries; however, they did diminish them considerably, particularly in the case of the hemapoietic and sex tissues and the intestinal tract. DNA and RNA synthesis was near normal. The combination of bone marrow, antibiotics, and vitamins was the most effective. The lymphatic system was not as well protected and remained hypoplastic even after the first year following irradiation. The ovaries were largely unaffected, while the testes were seriously injured. Survival of the acute stage of radiation injury was probably due to the protective and therapeutic effect on hematopoiesis and on the intestinal tract. Protection of animals seemed to lessen pathological processes during the first months after irradiation, but this effect disappeared with time and the later manifestations of the radiation injuries and chronic and acute inflammatory processes appeared. (CFSTI)

43455 STUDIES OF RADIOPROTECTIVE EFFECTS OF 3,3'-DITHIOBISPROPIOAMIDINE. Robev, S.; Baev, I.; Panov, N. (Inst. of Radiology and Radiation Protection, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 1035-7(1966). (In Russian).

White mice were given x ray doses of 700, 800 and 900 R, after

being injected with a sterile solution of 3-3'-DBPA or cystamine just before irradiation. The cystamine dose was 150 mg/kg of body weight, and the 3-3'-DBPA dose was 100 mg/kg of body weight. The survival 30 days after irradiation was taken as a measure of the effectiveness of the radioprotective substance. The results showed a 30% survival for 3-3'-DBPA compared to 38% for cystamine at a dose of 900 R, a 63% survival for 3-3'-DBPA compared to 90% for cystamine at a dose of 800 R, and a 87% survival for 3-3'-DBPA compared to 92% for cystamine at a dose of 700 R. The controls showed no survivors. It is concluded that 3-3'-DBPA is a good radioprotective agent. (TTT)

43456 THE EFFECT OF COOLING REGIMENS ON THE TRANSPLANTATION POTENTIAL OF MARROW. **Lewis, Jerry P.; Passovoy, Mitchell; Conti, S. Arthur; McFate, Patricia A.; Trobaugh, Frank E. Jr. (Presbyterian-St. Luke's Hospital, Chicago). Transfusion, 7: 17-32 (Jan.-Feb. 1967).**

Femoral bone marrow of mice was cooled at controlled rates to various temperatures, thawed rapidly, and injected into lethally irradiated, isogeneic CAF_1 mice. After the animals were sacrificed, the repopulating potential of the test marrow was estimated by a bioassay technic. These studies were designed to determine the rate of cooling in each of several temperature ranges that would contribute to the optimal preservation of stem cell viability. The bone marrow was suspended in Hanks' solution containing 12% glycerol and 4% calf serum. One ml samples of the suspension were frozen at controlled cooling rates and after thawing the colony producing potential was determined in irradiated recipients. The rate of cooling to freezing, the duration of the prefreezing plateau, and the temperature at which freezing was initiated did not affect the repopulating potential of marrow in irradiated mice. However, the repopulating potential of marrow decreased in a linear fashion as the postfreezing plateau was lengthened or as the rate of cooling from freezing to –100°C was increased. The dose of marrow necessary to provide protection against radiation varied widely, even within the same strain of animal. Thus, in one strain the number of isologous marrow calls needed for 300-day protection of 50% of the CAF_1 female mice irradiated with 900 R ($PD_{50/30}$), was 1.06×10^6 with 95% confidence limits of 0.42×10^6 and 2.51×10^6. In another strain the $PD_{50/30}$ for CAF_1 female mice irradiated with 850 R was 2.37×10^4 cells with 95% confidence limits of 1.70×10^4 and 3.31×10^4. (BBB)

43457 INFLUENCE OF X-IRRADIATION UNDER HYPOTHERMIA UPON THE INTESTINAL MUCOSA. Seki, Susumu (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 14: 637-68(Dec. 1965). (In Japanese).

Wistar-strain rats weighing 170 to 220 g were subjected to whole-body x radiation at doses of 600 and 1000 R and to abdominal irradiation at doses of 800 and 1200 R under hypothermia and normal body temperature; the effects on their intestinal mucosa were studied. The water content of the mucosa increased on the third day after irradiation, tended to recover gradually until the tenth day, and then returned rapidly to its normal state. The water increased considerably as the dose was increased; its increase in the hypothermia groups was slight and returned relatively soon to its normal state at all doses. As for the electrolytes, Na increased and K decreased; these changes were slight on the third and tenth day in the hypothermia groups. There were no differences observed between the abdominally and whole-body irradiated groups. Cholinesterase activity decreased after irradiation; in the hypothermia groups its decrease was slight on the third, tenth, and twelfth day. Alkaline phosphatase increased and reached a peak on the tenth day; there was no difference between the hypothermia and normal temperature groups. Histological examination revealed that intestinal change was not so remarkable in the whole-body irradiated groups as in the abdominally irradiated groups. Recovery from these changes was more rapid in the hypothermia groups. These changes (vacuolization, disappearance of nucleus, disintegration, atrophy and swelling of grandular and villous epithelium) were greater in the duodenum and decreased in the jejunum, ileum, and colon. From these results, it appeared that the effects of radiation on the intestinal mucosa of the rat were less under hypothermic conditions than under conditions of normal body temperature. (NSA of Japan)

43458 BASIC STUDIES ON THE RADIOSENSITIVITY AND THE OXYGEN TENSION IN TISSUE. Kamijo, Norihiro (Shinshu Univ., Japan). Shinshu Igaku Aasshi, 14: 769-87(Dec. 1965). (In Japanese).

The relation between the radiosensitivity of tumors and the oxygen tension of the tumor tissue of Rhodamin sarcomas transplanted in Wistar-strain female rats was studied using a platinum electrode of the open-tip type. The oxygen tension of Rhodamin sarcoma was 72% lower than that in normal tissue and tended to decrease in accordance with the changes in tumor tissue induced by x radiation. In general, the tumor volume rapidly decreased in the group with high oxygen tension and slowly in the group with low oxygen tension. In the general hypothermia group, the oxygen tension decreased in both normal and tumor tissues; the degree of decrease was larger in the former than in the latter. Consequently, the oxygen tension in tumor tissue was relatively enhanced by general hypothermia. When a 0.24% hydrogen peroxide solution was injected intraarterially or intratumorally, the oxygen tension rapidly increased in both normal and tumor tissues; it decreased rapidly in normal tissue and somewhat slower in the tumor tissue. Oxygram was clinically applied in patients with cervical erosion; the oxygram in the erosion region was almost the same as in the normal region. In patients with uterine cervix cancer, no differences in the oxygram were observed between the lesion and the normal tissue when hemorrhage was caused by insertion of the electrode. But in cases with little hemorrhage, the oxygram of the lesion was lower than that of the normal tissue. (NSA of Japan) (TSS)

43459 STUDIES ON THE X-IRRADIATION UNDER HYPOTHERMIA BY THE POLAROGRAPHIC METHOD. Araki, Kenji (Shinshu Univ., Japan). Shinshu Igaku Zasshi, 14: 753-68 (Dec. 1965). (In Japanese).

The relative oxygen tensions of normal and tumor tissues and their change under general hypothermia in rabbits bearing Brown-Pearce tumor and rats bearing Rhodamin sarcoma were studied by polarography; the radiosensitivities of normal and tumor tissues were estimated. The relative oxygen tension was lower in both Brown-Pearce tumor and Rhodamin sarcoma than in normal muscular tissue, 89% and 71% on the average of that in the latter, respectively. In the rabbits with Brown-Pearce tumor, the relative oxygen tension decreased in order of normal muscular tissue, tissue surrounding the tumor, and tissue in the middle of the tumor. Measurement of the relative oxygen tensions of several organs in adult male rabbits showed that the oxygen tensions of liver and spleen were the highest, about 2.5 times that of muscle; the oxygen tension of the kidney was close to the values for the liver and spleen. Those of the digestive canals decreased in order of small intestines, stomach and large intestines, and were, on the average, 30% higher than that of muscle. The oxygen tension of skin was 10% lower than that of muscle; that of bone marrow was about one-half that of muscle. The change of the relative oxygen tensions of muscular and tumor tissues under general hypothermia was as follows: In the spontaneous breathing group, the oxygen tension of normal tissue was rapidly reduced but that of tumor tissue was slowly reduced when the body temperature was lowered; this difference was, remarkably, below 31°C of body temperature. On the other hand, in the group that was subjected to tracheotomy and received an oxygen flow of 500 ml/min, the oxygen tension of the normal tissue decreased slowly in the range of 35° to 31°C, and decreased more rapidly than in tumor tissue below 29°C. (auth)

43460 NUTRITIONAL AND PHYSIOLOGICAL ROLE OF SILICIC ACID IN CROPS. XIII. EFFECT OF SILICIC ACID ON THE RADIATION-RESISTANCE OF WATER-FIELD RICE PLANTS. Takahashi, Eiichi (Kyoto Univ.). Nippon Dojo Hiryogaku Zasshi, 37: 183-8(Feb. 1966). (In Japanese).

It is well known that water-field rice plants strongly absorb silicic acid and that the effect of silicic acid on the plants is more remarkable under adverse circumstances than under normal conditions. Therefore, the influence of silicic acid nutrient on radio-induced abortion in water-field rice plants was investigated. Infant rice plants received different amounts of silicic acid nutrient before or after γ irradiation at doses of 300 to 4800 R; the degree of abnormality induced by the irradiation was examined in relation to the amount of silicic acid given before or after irradiation. It was found that there was prompt and delayed radiation injury. The radiation resistance of infant rice plants was remarkably increased when a sufficient amount of silicic acid was applied before irradiation; silicic acid applied after irradiation affected recovery of the rice plants. (NSA of Japan) (TSS)

43461 INFLUENCE OF PROPERTIES OF COLLOIDS ON DISTRIBUTION OF RADIOCOLLOIDS. Villar, G. E. Bol. Fac. Ing. Agrimens. Montevideo, 9: 739-61(July 1966). (In Spanish).

The administration of radioisotopes as colloidal systems cause great changes in their biological behavior. Their localization in the organism depends on their particle size. Suspense ions having large particles are located mainly in the injection site or in its neighborhood, a circumstance which makes the intracavitarian application of some radiocolloids, such as ^{198}Au, ^{32}Pr (as chromic phosphate), and ^{90}Y (as hydroxide), advisable. Within the organism the emulsions undergo a series of metabolic degradation processes leading to the reduction of particle size and permitting a successive scanning of several organs. The chemical research in the field of radiocolloids is of the greatest importance for the advance of medical applications of radioisotopes. (25 references.) (auth)

43462 CONTROL OF PSEUDOMONAS AERUGINOSA IN AN EXPERIMENTAL MOUSE COLONY. McDougall, Patricia Taylor; Wolf, Norman S.; Stenback, Wayne A.; Trentin, John J. (Baylor Univ., Houston, Tex.). Lab. Anim. Care, 17: 204-14 (Apr. 1967).

The effects of various control measures on incidence of Pseudomonas aeruginosa in a mouse colony were investigated. The effectiveness of immunization and antibiotic treatment for protection of lethally irradiated mice from early death due to P. aeruginosa was determined. P. aeruginosa could be cultured from several sites within the body of normal mice from this conventional colony. Acidified drinking water (0.005N HCl) greatly reduced the percentage of positive P. aeruginosa cultures from drinking water bottles and from the mice. Mice were irradiated with a supralethal dose (770 R) of x rays, and in some cases were treated with antibiotics and immunized. Active and passive immunization and treatment with several anti-gram-negative antibiotics failed to protect lethally irradiated mice from death due to P. aeruginosa. Gentamycin and streptomycin, alone or in combination, were effective. In some experiments combination of the two antibiotics gave better results than either antibiotic alone. Treatment with gentamycin or gentamycin plus streptomycin allowed bone marrow transplantation experiments in mice infected with P. aeruginosa to be carried out successfully. (BBB)

43463 THE INFLUENCE OF DIFFERENT APPLICATION OF FATS TO IRRADIATED ANIMALS ON THEIR RATE OF SURVIVAL AND THE LEVEL OF GLYCOGEN IN THE LIVER. Nemec, Rudolf (Research Inst. for Human Nutrition, Bratislava). Biologia (Bratislava), 22: No. 2, 118-24(1967). (In Czech).

Survival and glycogen content in the liver was studied in rats fed linseed oil or coconut oil administered in different manners after whole-body irradiation with 600 R. No significant differences owing to the two different fats were found. The manner in which these were administered was, however, important; when half of the total amount of the fat was introduced directly in the stomach, an increased resistance to the irradiation was noticed. (JPRS)

43464 PROTECTIVE ACTION OF SOME CHLORTETRACYCLINE DERIVATIVES DURING RADIATION DAMAGE OF YEAST. Kriger, Yu. A.; Tambiev, A. Kh.; Zakirov, L. A.; Mel'nikova, N. L.; Plakunov, V. K. (Moscow State Univ.). Nauch. Dokl. Vyssh. Shk. Biol. Nauki, No. 4, 94-6(1965). (In Russian).

Radioprotective effects of several chlortetracycline derivatives for cells of Saccharomyces vini that were exposed to 80kR γ radiation at a dose rate of 3600 R/min were determined. Solutions of anhydrochlortetracycline (AC), aureon (A), aureonamide (AA), chlortetracycline (C), chlortetracycline-MeI (CMI), dedimethylaminoaureomycinic acid (DAA), and isochlortetracycline (IC) in 5% ethanol at concentrations of 10^{-4}M were added to cell suspensions 20 min prior to irradiation. Of the derivatives tested, aureon offered the most protection; 60% of the cells survived. Percent survival of cells in suspensions treated with AC, AA, C, CMI, DAA, and IC was 33, 50, 55, 52, 36, and 48% respectively. In the control sample, 20% of the cells survived. (B.H.S.)

43465 RESULTS OF TREATMENT OF BREAST CANCER AT ABERDEEN ROYAL INFIRMARY 1940–55. Philip, James F. Brit. Med. J., 1: 323-31(Feb. 11, 1967).

Use of surgery and radiotherapy in the treatment of 1335 cases of breast cancer is described, along with the resulting cure rates and complications. Radium therapy was used alone or in association with surgery for some patients up to 1936, and, though it produced some 5-yr survivors, it was soon given up because of its morbidity: radionecrosis of skin and ribs, brachial neuritis, and sometimes hemorrhage. X-ray therapy can inactivate some breast cancers, and in other instances viable tumor tissue may become enclosed in a dense bed of fibrous tissue, probably prolonging the patient's life but not curing the disease. In association with radical surgery it may increase the 5-yr survival rate to a significant degree. The effectiveness of local mastectomy and x-ray therapy has been proved; it has a low morbidity, and generally the absolute 5-yr survival rate is ~42%. Shoulder-joint disability occurred most commonly after radical operation, especially when followed by x-ray therapy, but it also arose in some patients treated by local mastectomy and x-ray therapy and in those treated by radiation alone. The disability ranged from slight to severe, and in its worst form developed to frozen shoulder. Radiation-induced morbidity of other types is also described. In some earlier cases of the series radionecrosis was common and appeared up to many years after treatment. This was a particularly intractable complication, sometimes responding to conservative treatment, but only after many months, and always apt to recur. The worst cases called for plastic surgery procedures. Some degree of pneumonitis was usually evident after irradiation. Severe damage to the lung parenchyma seldom arose, but if it occurred it caused symptoms varying from an irritable nonproductive cough to dyspnea. Irradiation fractures of ribs did not cause more than a temporary discomfort, lasting for a few weeks, but irradiation fracture of the humerus caused much distress to the patient until false joint formation took place. (BBB)

43466 PYELONEPHRITIS IN THE ISOTOPE RENOCYSTOGRAPHIC PATTERNS. Kapuscinski, Andrzej. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 425-33(May-June 1967). (In Polish).

The aim of the work is an evaluation of the isotope renocystographic technique in the diagnosis of pyelonephritis. The examinations were performed by recording of the radioactivity curves in the kidneys and bladder areas after intravenous administration of ^{131}I-sodium hippurate. In cases of pyelonephritis characteristic changes are observed in the renocystographic curves. The most marked anomalies are: irregularity of the renal curves course (distinct radioactivity oscillations) asymmetry of the curves and flattening of the tracing. In the vesical radioactivity curve characteristic patterns are detectable in cases of pyelonephritis. The problem of preparation of the patient for the renocystography performance is discussed in the aspect of degree of hydration of the organism and of other technical problems. The results of 800 investigations performed in various kidney diseases demonstrate that the renocystography may serve as a valuable practical measure in the diagnosis of pyelonephritis. (auth)

43467 LYMPHOGRAPHY IN SECONDARY LYMPHATIC EDEMA. Sloniewicz, Witold; Kucharczyk, Kazimierz; Lerch, Krzysztof; Zaluska, Jozefa. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 443-8(May-June 1967). (In Polish).

The causes and mechanisms of secondary lymphatic edema in cases of malignant neoplasms treated by radiotherapy are discussed. These observations are based on lymphographic examinations. (H.L.W.)

43468 ROENTGENTHERAPY OF CANCER OF PHARYNX WITH CROSSED BEAMS. Skolyszewski, Jan; Pawlicki, Marek. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 449-52(May-June 1967). (In Polish).

A technique is presented that is applied in the Oncologic Institute in Krakow, in cases of cancer of the pharynx. The technique is based on the irradiation of the tumor site with crossed beams in conventional deep therapy. This technique resembles the Paterson method. (auth)

43469 STAFF X IRRADIATION IN THE COURSE OF BRONCHOGRAPHY AND BARIUM ENEMA PROCEDURES. Lobodziec, Wlodzimierz; Lubas, Barbara. Pol. Przegl. Radiol. Med. Nuklearnej, 31: 475-8(May-June 1967). (In Polish).

The exposure of the radiologic department staff (radiologists and radiographers) to x irradiation in the course of colon and bronchography examinations was assayed. The results of tests are presented in five tables. (auth)

43470 APPLICATION OF LASERS. Goodwin, D. W. (Royal Radar Establishment, Great Malvern, Eng.). Ann. Occup. Hyg., Suppl., 23-9(July 1967).

A resumé is given of laser applications as a research tool and for ranging and metrology. These were selected from a rapidly increasing list of applications in the medical field, for communications, welding, and plasma diagnostics. There is no doubt that the laser as a source of coherent optical power is proving a most valuable but sophisticated tool. (auth)

43471 BRAIN SCAN ARTIFACT FROM SALIVA CONTAMINATION. Engbring, N. H. J. Amer. Med. Ass., 199: 861(Mar. 13, 1967).

A problem encountered in brain scanning with ^{99m}Tc, resulting in erroneous diagnosis, is reported with reference to a case in which an artifact was caused by saliva containing the isotope. A 75-year-old woman who was comatose and hemiplegic because of a presumed cerebrovascular accident was submitted to a brain scan. She was given 7.7 mCi of ^{99m}Tc in the pertechnetate form intravenously. An area of intense radioactivity was observed in the occipital region on the right lateral view, suggesting scalp lesion, but examination revealed no evidence of trauma or other abnormality. It was observed that saliva was trickling from the patient's mouth and pooling under her head. Technetium-99m, as the pertechnetate, is handled in the body in a manner similar to iodide. It is rapidly concentrated in the thyroid, gastric, and salivary glands and in the mucosal linings of the respiratory tract. The concentration in salivary glands is intense, and presents a disadvantage in vertex scanning of the brain. The ^{99m}Tc secreted in the saliva causes no particular problem if the saliva is swallowed; however, a problem may arise when the patient is comatose or otherwise unable to handle such secretions. Intrave-

nous rather than oral administration of the ^{99m}Tc will not reduce the salivary secretion of this radioactive material. The use of atropine to inhibit salivation may minimize this problem. (BBB)

43472 EVALUATION OF GAMMA RAY SPECTROMETERS. **Witherell, Egilda de Amicis; Cowing, Russell F. (New England Deaconess Hospital, Boston). Contract AT(30-1)-901. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 847-51(Aug. 1967). (NYO-901-65).**

A careful evaluation of several gamma ray spectrometers whose use was intended for clinical studies and in research was carried out. A series of gamma ray sources was utilized as standards. Such factors as reproducibility of measurements, stability of gamma ray energy calibration, linearity of amplifier problems of varying count rates, and resolution of detectors should be carefully checked before utilizing gamma ray spectrometers. The technical factors involved need not be completely understood but tests and measurements will point to individual technical details. The evaluation of the spectrometers is presented so that workers in the medical radiation field will be aware of the need to carefully check the instrumentation from which data are derived. (auth)

43473 A SIMPLE METHOD FOR MEASUREMENT OF ^{99m}Mo CONTAMINATION IN ^{99m}Tc. **Berke, Raymond A.; Johnson, Raymond M.; Henegar, George C. (Veterans Administration Research Hospital, Chicago. Northwestern Univ., Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 844-6(Aug. 1967).**

A method is described for the assay of ^{99}Tc for ^{99}Mo content by means of a Geiger counter. The method can be used by individual users of ^{99}Mo generators for ^{99}Tc. The advantages of ^{99}Tc over ^{131}I for use in clinical studies are discussed, and AEC requirements for ^{99}Tc for use in clinical studies are reviewed. It is pointed out that the amount of ^{99}Mo present in ^{99}Tc varies with the generator. (C.H.)

43474 USE OF THE UNCOMPENSATED HIGH ENERGY PHOTON BEAM IN RADIATION THERAPY. **Van Roosenbeek, Earl (Univ. of Texas, Houston). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 890-3(Aug. 1967).**

A method is described for the therapeutic use of the uncompensated high-energy photon beam originating in high-energy accelerators. The advantages of the method for the treatment of neoplasms of the pelvic region are discussed. It is pointed out that facilities for this type of operation are present in some types of accelerators and could be easily adapted in other types. (C.H.)

43475 COMPARATIVE STUDY OF THE GAMMA CAMERA AND RECTILINEAR SCANNER. **Collica, Carl J.; Robinson, Theodore; Hayt, David B. (Misericordia-Fordham Affiliation, Bronx, N. Y.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 761-79(Aug. 1967).**

Results are reported from a comparison of the performance of the γ camera and rectilinear scanner for use in scanning tracer doses of radioisotopes used in diagnosis. It was shown that the scans made by the γ camera are as good, if not better than, those obtained using a conventional (3-in-dia NaI scintillation crystal) rectilinear scanner. The γ camera was found to be more flexible and can be applied to many other medical studies such as dynamic processes. (C.H.)

43476 THE CLINICAL APPLICATION OF THE ANGER GAMMA CAMERA TO DISEASES OF THE THYROID. **McAllister, John D.; Alexander, Gilbert H.; Goldberg, Harold E.; Marasco, Joseph A. Jr. (St. Francis General Hospital, Pittsburgh). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 780-5(Aug. 1967).**

The use of the Anger γ camera for the visualization of the distribution of ^{131}I in the thyroid gland for the diagnosis of thyroid diseases is discussed. It is concluded that correlation of the history and physical findings with the scintiscan is the most important feature of this examination. Anatomic detail of the thyroid gland as visualized by the gamma camera is excellent and with the increased speed of the camera as opposed to rectilinear scanning, considerable versatility is possible in establishing the nature of a palpable node. (C.H.)

43477 LINGUAL THYROID SCANNED WITH ^{99m}Tc PERTECHNETATE. REPORT OF TWO CASES. **Dodds, Wylie J.; Powell, Malcolm R. (Univ. of California, San Francisco). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 786-91 (Aug. 1967).**

Technetium 99m pertechnetate scanning of 2 children with lingual thyroid glands proved to be a particularly efficient and preferable method of localizing ectopic thyroid in the pediatric age group. The subject of lingual thyroid is reviewed. (auth)

43478 DYNAMIC CLINICAL STUDIES WITH RADIOISOTOPES AND THE SCINTILLATION CAMERA. SODIUM IODOHIPPURATE ^{131}I RENOGRAPHY EMPLOYING ELECTRONIC CRYSTAL SPLITTING. **Burke, Gerald; Halko, Arlene (Michael Reese Hospital and Medical Center, Chicago). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 792-800(Aug. 1967).**

The conventional scintillation γ camera was modified by introduction of an electronically split crystal whereby both kidneys can be studied simultaneously yet independently. The necessary modifications in instrumentation and results of spatial resolution studies are described in detail. The split-crystal scintillation camera was used for dynamic studies of renal function with sodium iodohippurate ^{131}I (hippuran). This approach permits constant visual monitoring of the passage of iodohippurate ^{131}I through the parenchyma and pelvis of the kidney concomitant with the inscription of the renogram curve. It thus permits more definitive interpretation of the renogram since it allows direct, rather than intuitive, correlation of the various segments of the renogram curve with the intrarenal location and intercompartmental transit of iodohippurate ^{131}I at that time. The results obtained indicate that although diverse renal disease states may produce a similar abnormality of renogram contour, the concomitant scintiphotographic study may permit delineation of the underlying renal pathophysiology. (auth)

43479 RADIOISOTOPE SCANNING OF TUMORS. **Bonte, Frederick J.; Curry III, Thomas S.; Oelze, Russell E.; Greenberg, Alvin J. (Univ. of Texas, Dallas, Parkland Memorial Hospital, Dallas). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 801-12(Aug. 1967).**

Extracranial tumors may be scanned by much the same method, and employing the same apparatus and the same group of tracers, as are used to detect intracranial tumors. The primary mechanism of tumor labeling seems to be the presence of tracer in the tumor blood pool. Secondary mechanisms, which may obtain in selected tumors, probably include binding of host proteins by tumor cells, and entry of tracer into protein-containing spaces within the tumor, such as foci of necrosis. Eighty-five scans were obtained using ^{131}I-labeled human serum albumin as tracer in 70 patients, and illustrative ones are presented. Factors affecting scan interpretation are discussed. In its present form, radioisotope scanning will contribute to the management of only a few individual cases. Possible approaches to improvement of information from tumor scanning are suggested. (auth)

43480 RETENTION, DISTRIBUTION, AND ABSORPTION OF INHALED ALBUMIN AEROSOL AND ABSORBED DOSE ESTIMATES FROM ITS ^{131}I AND ^{99m}Tc LABELS. **Pircher, Felix J.; Knight, Conrad M.; Barry, William F.; Temple, Joel R.; Kirsch, William J. (Duke Univ., Durham, N. C.). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 813-21(Aug. 1967).**

The retention, distribution and absorption of labeled human serum albumin aerosol nebulized in a Bird Micronebulizer and inhaled with the aid of a Bird Mark VII respirator was measured by scanning 4 normal subjects and 2 patients with total laryngectomies. The results indicate that an average of 14 percent of the total nebulized dose was retained in the lungs and an average of 10.5 percent outside the lungs. The absorbed doses from ^{131}I labeled albumin aerosol to the lungs were approximately 4.3 rads; to the whole-body 153 millirads. With ^{99m}Tc the doses were reduced by a factor of 9. In more than 150 examinations of patients with lung disease, areas of ventilation deficits could be detected and localized by radioisotope scanning. The best results were obtained in patients inhaling the aerosol over a period of 20 minutes while breathing slowly and deeply, and with the respirator set at a flow rate of not more than 6 liters per minute and a pressure of 7 to 15 cm. of water. The chest scans were of better quality when delayed for 1 to 2 hours. It appears that the procedure meets the requirements for use in diagnosis and clinical investigation of lung diseases. (auth)

43481 CORRELATIVE ASSESSMENT OF THE MACROALBUMIN LUNG SCAN WITH THE CLINICAL AND ROENTGENOGRAPHIC CHEST FINDINGS. **Sieniewicz, D. J.; Rosenthall, L.; Herba, M. J.; Burgess, J. H. (McGill Univ., Montreal). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 822-34(Aug. 1967).**

A clinical, roentgenographic, and scanning review of varying lung disease entities in 385 patients was analyzed. In all, 507 lung scans using macroaggregates of iodine-131-labeled human serum albumin as tracer were assessed in this survey. Serial scannings, a maximum of 7, were performed in some patients, particularly in those with a diagnosis of pulmonary emboli and infarcts. A positive scan indicated by an avascular area in a segment, lobe, or lung was noted in many conditions. However, negative scans were also noted in some patients diagnosed as having conditions in which avascularity should be demonstrable,

particularly emboli and infarcts. The time relationship of the scanning to the onset of disease, and the position of the lesion as compared to the position of the patient for scanning should be considered. Lesions adjacent to the diaphragmatic surface of the lung and those in the left lower lung field are particularly difficult to assess. As an adjunct to other means of assessment of the patient, the lung scanning is helpful. It is performed easily, without much difficulty to the patient and is useful when an avascular state is suspected. Data suggest that it is the most valuable test in the diagnosis of pulmonary embolism and infarction, especially when combined with the chest roentgenogram. (auth)

43482 EVALUATION OF PULMONARY FUNCTION USING ^{133}Xe AND THE SCINTILLATION CAMERA. Loken, Merle K.; Westgate, Hugh D. (Univ. of Minnesota Hospitals, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 835-43 (Aug. 1967).

Pulmonary function was studied in 51 patients with a variety of lung diseases using serial scintiscans made after the administration of ^{133}Xe either by inhalation or intravenous technique, or combinations of the two methods. Spirograms for each patient were recorded on a Godart Pulmotest that directly recorded tidal volume, respiratory rate, minute volume, vital capacity, maximum flow rates, and maximum breathing capacity. Blood samples were analyzed for CO_2 and pH. Chest roentgenograms were also obtained. Results obtained in various plumonary diseases are reported. The advantages of using ^{133}Xe for lung function tests are discussed. It is concluded that the technique is very sensitive to changes of pulmonary function and gives a quantitative estimate of the degree of pulmonary involvement with disease. (C.H.)

43483 FACTORS THAT DIMINISH RADIATION LETHALITY. Reichard, Sherwood M. (Medical Coll. of Georgia, Augusta). Radiology, 89: 501-8(Sept. 1967).

Protection against the lethal effects of radiation was obtained in rats by several procedures that alter the reticuloendothelial system (RES). Thus, trauma resistance produced in animals through repeated exposures to sublethal doses of shock, previously shown to be associated with the RES, reduced the mortality following 750 R x irradiation from 80 to 25 per cent. Impairing the function of the RES eliminated this acquired resistance to both traumatic shock and x irradiation. Extracts prepared from the spleens and plasma of resistant animals and administered to normal animals were found to protect them against radiation lethality. Other procedures which stimulate phagocytic activity of the RES such as injections of zymosan, a cell wall preparation of yeast, repeated injections of saccharated iron oxide, denatured human serum albumin aggregate, and administration of bacterial endotoxins also increased survival to x irradiation. In all instances, impairment of the RES overcame this protection. A humoral mechanism seems to be involved, since protection can be passively transferred to otherwise unprotected rats. The RES, therefore, seems to be concerned with the production or concentration of an active factor capable of altering physiological adaptation to traumatic shock and x irradiation. (46 references.) (auth)

43484 BRAIN SCANNING AFTER CEREBRAL ANGIOGRAPHY. Anderson, William Bruce; Siemsen, Jan K. (Univ. of Southern California, Los Angeles). Radiology, 89: 492-4(Sept. 1967).

It has been postulated that brain scans should not be performed immediately after angiography because changes in the blood-brain barrier make the scans uninterpretable. Results are presented of scanning within two weeks after angiography in 69 patients with 116 angiograms. There were no false positive studies. They conclude that cerebral angiography poses no contraindication to brain scanning and angiographically induced changes in the brain scan are apparently rare. (auth)

43485 INVESTIGATION OF SPLENIC FUNCTION WITH ALTERED ERYTHROCYTES MARKED WITH RADIOCHROMIUM. Franke, W.-G.; Hennig, K.; Woller, P.; Boettger, H. (Medizinische Akademie Carl Gustav Carus, Dresden, Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Radiol. Diagn., 8: 395-8 (1967). (In German).

A method for the recording of kinetics of damaged erythrocytes marked with radiochromium and the interpretation of results yielded by the method are reported. The significance for the evaluation of partial function of the splenic and extrasplenic reticuloendothelial system is described. (auth)

43486 STATISTICAL INVESTIGATIONS FOR CONTRAST INTENSIFICATION IN SCINTIGRAPHY. Woller, P.; Hennig, K. (Medizinische Adademie Carl Gustav Carus, Dresden). Radiol. Diagn., 8: 399-404(1967). (In German).

The statistical distribution of output signals was investigated for contrast intensifier on the principle of impulse interval discrimination and impulse rate subtraction. In this respect the impulse rate subtraction is most favorable for scintigraphy. The statistical behavior is of particular importance in high resolution collimators in respect of the utilization of resolution power. (auth)

43487 INVESTIGATIONS ON THE PASSAGE OF RADIOGOLD COLLOID THROUGH THE SMALL INTESTINE. Georgi, P.; Altenbrunn, H.-J.; Guetz, H.-J. (Institut fuer Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Radiol. Diagn., 8: 285-9(1967). (In German).

The applicability of radiogold colloid for the determination of passage through the small intestine in control persons, patients with chronic diarrhea, and after gastric resection is reported. (tr-auth)

43488 ON ^{3}H-THYMIDINE INCORPORATION IN HUMAN GASTRIC MUCOSA IN GASTRITIS (AUTORADIOGRAPHIC INVESTIGATION). Steenbeck, L.; Wolf, G. (Institut fuer Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Radiol. Diagn., 8: 291-5(1967). (In German).

The in vitro incorporation of ^{3}H-thymidine in normal and pathological gastric mucosa of man was investigated autoradiographically. Results showed that the number of glandular ducts which contained marked cells was highest in chronic atrophic gastritis; the percentage of marked foveal cells is significantly high in chronic atrophic gastritis; and the degree of marking of individual cells rises with increasing intensity of inflammation. It is most intense in chronic atrophic gastritis. (auth)

43489 POSSIBILITIES OF ERRORS AND FALSE INTERPRETATIONS IN ISOTOPE NEPHROGRAPHY. Schneider, G.; Strangfeld, D.; Siewert, H.; Buchali, K. (Medizinische Univ. der Charite, Berlin). Radiol. Diagn., 8: 359-63(1967). (In German).

The nephrography curve can be well reproduced on repetition. False interpretations due to different sensitivity of the registration system or due to difference in the dosage of the test substance administered to the patient can be eliminated through measurements. Out of the parameters used, Tm (maximum height of the curve) is evidently the most certain for diagnostic purposes. In the case of collimators, a geometrically wrong adjustment in the longitudinal axis by 2 to 4 cm does not play any significant role. (auth)

43490 DIAGNOSIS OF RENAL FUNCTION WITH THE SCINTILLATION CAMERA. Altenbrunn, H.-J.; Georgi, P. (Institut fuer Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Radiol. Diagn., 8: 365-70(1967). (In German).

With the help of the Anger scintillation camera it is possible in a short time to take pictures of the distribution and accumulation of ^{131}I-hippurate in both kidneys simultaneously. This enables a visualization of the individual functions of the kidneys and evaluation of renal function. Even functional disturbances of smaller are areas are demonstrable. This method is specially advantageous in the evaluation of renal function in small children and in pyelonephritis. (auth)

43491 ON THE DIAGNOSIS OF BRAIN TUMORS WITH ^{197}Hg-NEOHYDRINE GAMMA-ENCEPHALOGRAPHY. Koch, R. D.; Otto, H.-J.; Abraham, K. (Medizinische Akademie, Magdeburg, Ger.). Radiol. Diagn., 8: 385-9(1967). (In German).

The favorable half-life and the quick elimination of ^{197}Hg neohydrin led to the use of this radioactive compound in gamma encephalography. Glioblastomas absorb ^{197}Hg neohydrin at a high rate and show a marked focal intensity on measurement after 24 hours. A little poorer accumulation of activity in the tumor area and lesser increase of activity on second measurement seem to be characteristic of astrocytomas and oligodendrogliomas. Metastases are nearest to glioblastomas regarding the absorption of ^{197}Hg-neohydrin. A differentiation between neoplastic and non-neoplastic processes is possible. In application of ^{197}Hg-neohydrin the questions of radiation precautions lose their significance because of low radiation dose (considering whole-body radiation and radiation of critical organ). (auth)

43492 EXPERIMENTS CONCERNING THE CLINICAL APPLICABILITY OF TRIOLEIN TEST. Altenbrunn, H.-J.; Georgi, P.; Wangermann, G. (Institut fuer Krebsforschung, Deutsche Akademie der Wissenschaften, Berlin). Radiol. Diagn., 8: 391-4(1967). (In German).

After discussing the problem of triolein test the investigation of fat resorption in patients is reported. After simultaneous administration of ^{131}I-triolein and ^{14}C-stearic acid, the activity in serum and stools was determined. The results showed that the resorption of ^{14}C-stearic acid is quicker and more intensive than that of ^{131}I-triolein. It is concluded from significantly less excretion of ^{14}C in stools that the dehalogenation in intestinal lumen (which alone can

falsify the results) is low. Larger errors are to be expected through triolein charges which result in varying concentrations of tri-, di-, and monoglycerides. (auth)

43493 CONVENTIONAL IRRADIATION VS ^{60}Co THERAPY. Baclesse, Francois (American Hospital, Paris). J. Amer. Med. Ass., 200: 613(May 15, 1967).

A comparison was made between the clinical results and complications with 200-KV x-ray and ^{60}Co γ-radiation treatment of 316 cases of breast cancer. With conventional radiotherapy of 247 patients, 70 were still living at 5 yr (28.3%). Between the fifth and tenth year, 5 patients had a local recurrence. After 10 yr, 32 patients were alive and well (12.9%). The results of ^{60}Co therapy after 5 yr showed that the percentage of apparent cures was less than with 200-KV x-ray therapy (18.8% compared with 28.3%). This difference was explained by some patients being in a more advanced stage, a larger proportion of whom died in the first few years from blood-borne metastases. With conventional x-ray radiotherapy, local complications including telangiectasia, fibrosis, skin necrosis, and neurological lesions were common. Despite the lower 5-yr survival rates, the advantages of ^{60}Co were obvious, mainly because of the lack of these complications, enabling possible postirradiation major surgery to be performed. Thus out of 21 stage III patients submitted to ^{60}Co, 20 had a radical mastectomy and one a simple mastectomy. There were no postoperative complications apart from delayed wound healing in some cases. (BBB)

43494 THE SURGICAL IMPLICATIONS OF IRRADIATION DAMAGE TO THE BOWEL. Cuthbertson, A. M. (Peter MacCallum Clinic, Melbourne). Aust. N. Z. J. Surg., 36: 33-9 (Aug. 1966).

To study the clinical effects of bowel irradiation and to correlate them with the pathological changes taking place, 30 patients who were undergoing treatment for pelvic cancer were followed by serial sigmoidoscopy and biopsy. Thirteen received intracavitary radon alone, 9 were followed through megavoltage therapy, and 8 received both forms of treatment during the study. Sigmoidoscopy and biopsy were carried out at 1, 2, 4, and 12 weeks after removal of the radon or at similar intervals after commencement of megavoltage therapy. An attempt was then made to correlate the sigmoidoscopic appearance with the biopsy findings and symptoms. After the first week the rectum usually appeared normal. By the end of the second week the mild proctitis seen was characterized by redness and loss of mucosal pattern due to edema. Half returned to normal by 4 weeks and, with the exception of 2, the remainder had regressed by the 12th week. One who failed to regress had received a rectal dose of 7350 R from radon in 14 days. She developed a severe proctitis by the second week which persisted for many months. The other patient was found at 12 weeks to have a radionecrotic ulcer on the anterior rectal wall. She had received 8465 R. This ulcer was evidently precipitated by the biopsy. Two main symptom patterns were distinguished. Frequent small mucous bowel actions were accompanied by a rectal sensation and bleeding. These symptoms correlated well with the sigmoidoscopic appearances. Or, profuse watery diarrhea was accompanied by cramping abdominal pain. These symptoms bore little relation to the sigmoidoscopic findings and presumably were due to small bowel involvement. The histopathology of biopsy findings are described in detail for each dose level. (BBB)

43495 PROCEEDINGS OF 4TH ANNUAL MEETING OF THE JAPANESE ASSOCIATION OF NUCLEAR MEDICINE, NOV. 17, 18, 1964. VOLUME 4. Jap. Nucl. Med., 4: 1-93(1965). (CONF-641132).

Brief summaries are presented of 115 papers that discuss recent advances in the use of radioisotopes in the diagnosis of various pathological conditions. Topics discussed include the preparation of labeled pharmaceuticals for use as tracers, techniques for scintiscanning and whole-body counting, techniques for micro-autoradiographic studies, data recording systems, the use of computers for data analysis, the calibration of radiation detection instruments, and the design of an improved γ scintillation camera. Results of clinical studies in which radioisotopes were used as tracers and preliminary studies in animals are reported. (C.H.)

Radiation Effects on Animals

Refer also to abstracts 43343, 43356, 43392, 43407, 43445, 43462, 43545, 43548, and 43549.

43496 (AD-645205) ASSOCIATION OF AN ILLNESS WITH THE PRIOR INGESTION OF NOVEL FOODS. Revusky, Samuel H.; Bedarf, Erwin W. (Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.). Sept. 20, 1966. 13p. (USAMRL-694). CFSTI.

Rats were permitted to ingest a novel food and a familiar food. An hour later, they were x-irradiated. In a subsequent choice between these foods, their preference for the novel food was less than that of appropriate controls. (auth)

43497 (AD-645452) ABERRANT CORNEAL EPITHELIAL CELLS PRODUCED BY RUBY LASER IRRADIATION. Parr, W. H.; Fisher, Robert S. (Army Medical Research Lab., Fort Knox, Ky. Biophysics Div.). Oct. 31, 1966. 31p. CFSTI.

Rat corneas were exposed to either four joules per sq cm or eight joules per sq cm and were harvested at varying times following laser exposure. Corneal whole mounts were evaluated for changes in either the differential mitotic cell count or the mitotic index. Ruby laser radiation (6,943 A) produces aberrations in the corneal epithelium of the rat. At eight joules per sq cm both interphase cells and cells in active mitosis were obviously altered. At four joules per sq cm aberrant corneal epithelial cells became apparent immediately after laser irradiation, and some were still present 30 days later. The mechanism by which laser radiation alters the cornea remains obscure. (auth)

43498 (COO-1421-4) INTERACTING EFFECTS OF GAMMA RADIATION AND SODIUM HALIDE CONCENTRATIONS ON RAINBOW TROUT. Neuhold, John M.; Sharma, R. K. (Utah State Univ., Logan. Dept. of Wildlife Resources). May 1967. Contract AT(11-1)-1421. 28p. (CONF-670503-26). Dep. CFSTI.

From 2nd National Symposium on Radioecology, Ann Arbor, Mich.

Mortality of ^{137}Cs gamma-irradiated rainbow trout subjected to aquarium medium levels of sodium fluoride, sodium chloride, sodium bromide and sodium iodide displayed a significant response to either time by gamma dose, time by sodium halide concentration, or gamma dose by sodium halide concentration interactions. The interactions were concluded to be caused by radiation induced changes in oxygen uptake and sodium uptake and excretion. (auth)

43499 (RM-5272-PR) MATHEMATICAL MODEL FOR POST-IRRADIATION HEMATOPOIETIC RECOVERY. OKunewick, J. P.; Kretchmar, A. L. (RAND Corp., Santa Monica, Calif. Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). July 1967. Contracts F44620-67-C-0045; AT-40-1-GEN-33. 32p. Dep. CFSTI.

A mathematical model for post-irradiation hematopoietic recovery was constructed, based on the hypothesis that hematopoietic stem cells that are unable to reproduce as stem cells following irradiation may still retain an ability to differentiate. The model demonstrates both an abortive recovery rise and a true recovery rise following irradiation. The results obtained from this model are in good first-approximation agreement with the data reported from laboratory experiments. In the present calculations, an acute dose sufficient to destroy the reproductive capacity of 50% of the erythroid stem cells was assumed. In response to this dose, an abortive rise in circulating reticulocytes occurs in the model, peaking at about six days. True recovery follows at about 17 days. Both the abortive rise and the true recovery are also visible in those segments of the model representing the earlier precursor compartments, occurring at progressively earlier times for the more primitive cells. In contrast, the mature-erythrocyte compartment of the model shows no peak or rise above normal cell numbers after acute irradiation. Rather, at about two days after irradiation, the erythrocytes begin to decrease in number, reaching their lowest level (about 95% of the normal number) at about 16 days and beginning a return to normal at about 62 days. (auth)

43500 (TT-67-56008/2, pp 381-8) CYTOLOGIC CHANGES IN THE BONE MARROW CELLS IN SUBJECTS WITH OCCUPATIONAL EXPOSURE TO IONIZING RADIATION. Wichrzycka, E.; Leszko, B. Translated from Pol. Med. J., 6: 381-8(1967).

The mitotic connected abnormalities (M. C. Abn.) were estimated in 24 bone marrow smears of workers with occupational exposure to ionizing radiation. The type, number and localization of M. C. Abn. were similar to those reported in bone marrow smears of persons, who received 22.8 R to 368 R of irradiation, three and a half years after the accident. (auth)

43501 SOME OBSERVATIONS ON THE EFFECT OF IONIZING RADIATION AGAINST DESERT LOCUST. Heshamul-Huque (Ministry of Food and Agriculture, Karachi, Pakistan). Pakistan J. Sci., 15: 267-70(Nov. 1963).

The desert locust, Schistocerca gregaria, is a crop pest of international importance. Preliminary to development of an eradication program, the effect of ^{60}Co γ radiation on the insects was studied. Two-day-old eggs when exposed to doses of 90 and 120 kR failed to hatch. The most susceptible stage of the egg was when about one-quarter to one-third of the incubation period was completed; a dose of about 200 rad prevented most of the eggs from hatching. The least susceptible stage was about 12 hr before hatching when a dose of even 5000 rad had no adverse effect on hatching.

All desert locust hoppers of second to fifth instar died when exposed to radiation doses varying from 2.5 to 7 kR. Mortality increased with increase in the dose. The rate of metabolism slowed down in irradiated hoppers as none of them could molt although they lived long enough to complete one or two stages. The fifth instar hoppers, for example, lived for a maximum period of 21 days at a dose of 2.5 kR but none formed into adults. Intake of food was normal up to three days postirradiation. Afterwards, feeding was adversely effected until they were all dead. Younger stages were more susceptible to radiation than the advanced stage hoppers. When high doses (15 to 120 kR) were applied to young adults, they were rendered motionless within 24 hr and died within 96 hr of irradiation. An increased effect was observed with increase in dose. (BBB)

43502 AN IMPAIRMENT OF ANTIBODY PRODUCTION IN ADOPTIVELY RESTORED, LETHALLY IRRADIATED THYMECTOMIZED MICE. Tyan, M. L.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco). Clin. Exp. Immunol., 2: 121-31 (Jan. 1967).

To study the functional capacities of mature lymphoid cells in the absence of the thymus, homograft rejection and hemagglutinin production were assayed in normal and thymectomized lethally irradiated adult mice that had received spleen and lymph node cells from normal or previously sensitized syngeneic donors. The mice received 870 rad of whole-body x radiation, then nucleated syngeneic bone marrow cells from normal or sensitized donors. These mice were tested at intervals following irradiation for their ability to reject allogeneic and xenogeneic skin grafts and to produce hemagglutinins. The results showed that adoptively restored, thymectomized mice are capable of responding normally to skin homografts of varying antigenic disparity and of producing hemagglutinins to xenogeneic antigens. However, most mice that received lymphoid cells from normal donors were unable to produce hemagglutinating antibody in response to allogeneic antigens. Both 19S and 7S antibodies were produced by the thymectomized mice. (BBB)

43503 MONOCYTIC LEUKEMIA WITH γ-GLOBULIN PARAPROTEINEMIA AFTER X IRRADIATION AND CYTOSTATIC TREATMENT OF A MYOSARCOMA. Wildhack, R. (Allgemein Krankenhaus Barmbeck, Hamburg). Deut. Med. Wochenschr., 92: 255-7(Feb. 10, 1967). (In German).

Following surgical extirpation of a large myosarcoma from a 75-yr-old man, the patient was x irradiated over 13 fields with a 250-R surface dose, followed by administration of Trenimon for 1½ yr. A yr later severe skin and mucosal hemorrhages developed with a monocytic leukemia accompanied by a γ-globulin paraproteinemia. The differential blood picture showed 2% promyelocytes, 5% segmented nuclei, 8% lymphocytes, and 84% monocytes. There were 2000 thrombocytes/mm^3. Total protein was 7 g%. Protein fractions were albumin 40.6%, α_1-globulin 6.2%, α_2-globulin 7.3%, β-globulin 9.6%, and γ-globulin 36.2%. Immunoelectrophoretically, there was marked deformation of the γ-globulin arc in the cathodic region. Sternal puncture showed increased myeloid cell concentrations. The marrow cells corresponded to the monocytic elements of the blood, with increase in very immature promyelocytes to 36%, and forms transitional to monocytic cells. (BBB)

43504 THE RELATIVE BIOLOGICAL ACTION OF HIGH-ENERGY RAYS IN COMPARISON WITH 200 kv X-RAYS. Vrancheva, D. Rentgenol. Radiol., 5: No 3, 172-9(1966).

Pigs four-months-old were irradiated with 200 kv x-rays, γ-rays from a 1000 Ci ^{60}Co source, and 17.3 MeV electrons. The doses used for each type of radiation were 1300, 1800, and 2200 rad. The biological effectiveness of the radiation was determined on the basis of the cutaneous reaction. The results indicated that the action of high-energy radiation was weaker than that of the x-rays. With increasing doses of radiation, the difference in biological action due to the relative energy of the radiation increased. (JPRS)

43505 EKG CHANGES OCCURING UNDER THE EFFECTS OF A SUPERHIGH-FREQUENCY ELECTROMAGNETIC FIELD. Paliev, B.; Paliyev, B.; Goshev, Khr. Voenno Med. Delo, No. 4, 34-41(1966).

An EKG analysis of military personnel working around SHF fields was conducted. Findings were compared with data gathered from personnel not exposed to such fields. Results of the investigation are presented in tabular form. The cardiac characteristics of personnel exposed to SHF fields are summarized. A wide range of pulse rates wherein both substantial bradycardia and tachycardia were characteristic was noted. (ATD)

43506 EFFECTS OF IRRADIATION ON THE NERVOUS SYSTEM OF PERSONNEL EXPOSED TO MICROWAVE-RANGE FIELDS. Edelwejn, A. (Military Inst. of Aeromedicine, Warsaw). Lek. Wojsk., No. 9, 781-6(1966). (In Polish).

This study on the effects of microwave irradiation involved several thousand people working in military and civilian establishments. Three groups were considered. Group E was exposed to low power densities (of the order of 10 μw/cm^2) during a workday, in open or closed spaces, and within the range of the entire microwave band during pulse modulation. Group ES was exposed to conditions similar to those for group E, but with power densities of several tens of μw/cm^2 (10 to 100), irradiation from many directions, and more chances of exposure to microwave reflection and superimposition. Persons working in the open during periods averaging one month, exposed to low powers, or persons often exposed to the wave propagation line (surveyors) were also included. Subjects in group R were exposed to power densities of the order of several tens, and even several hundreds, of μw/cm^2, with almost continuous irradiation during a workday, and mostly in closed places. The following conclusions were drawn. The frequency of complaints of headache, dizziness, fatigue, and excessive perspiration among persons working within the microwave range depended on the length of employment and the degree of exposure to radiation. EEG changes, consisting of decreased alpha rhythms and decreased alpha-wave percentage, were observed only in persons exposed for prolonged periods of time to relatively high power densities. It was found that all persons tested, regardless of the degree of exposure and the length of employment, had a lower-than-average tolerance to intravenous administration of cardiazol. Tests were discontinued after treating 30 persons with it for fear of harmful side effects. The majority of subjects had symptoms of a quasi-neurotic syndrome closely approaching neurasthenia. The frequency distribution of symptoms was related to the length of employment, and seemed to indicate that a strong reaction to radiation occurred during the first years of exposure (three years of work) that was followed by gradual adaptation. Thereafter, a recurrence of adverse effects took place only after a longer interval. (ATD)

43507 STUDIES ON THE EFFECT OF SUPER-SOFT X-RAY IRRADIATION ON HAEMOGRAM OF RABBIT. Mizuno, Osamu (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi, 24: 215-36 (July 1966). (In Japanese).

Red blood cells were slightly increased in numbers following x ray doses of 300 and 600 R. Larger doses of 1000 and 2000 R resulted in a decrease in numbers. Doses of 300, 600, and 1000 R stimulated white blood cells to increase in numbers until the fifth day after which a decrease in numbers occurred. Doses of 2000 and 3000 R resulted in a temporary increase in white blood cells and a later decrease. (NSA of Japan) (TSS)

43508 MELANOGENESIS IN HUMAN SKIN FOLLOWING EXPOSURE TO LONG-WAVE ULTRAVIOLET AND VISIBLE LIGHT. Pathak, M. A.; Riley, F. C.; Fitzpatrick, T. B. (Massachusetts General Hospital, Boston). J. Invest. Dermatol., 39: 435-43(Nov. 1962).

It was thought that primary melanization (formation of new melanin) is induced only by light of wavelengths between 2900 and 3200 Å (the erythemal spectrum). Data are reported to show that this upper limit is too low and that both long-wave uv (3200 to 4000 Å) and visible light (4000 to 6500 Å) can also induce the formation of new melanin as well as immediate darkening of preformed melanin. The data were obtained from 21 subjects who were irradiated with a narrow band of monochromatic light from a high-intensity monochromator. Results showed that the spectrum which induces immediate pigment-darkening did not lie within the limits of previously accepted wavelengths (3000 to 4300 Å), but extended from 3000 to 6500 Å and perhaps up to 7000 Å. Some preliminary observations indicated that immediate pigment-darkening may be an oxidation reaction that takes place in the deeper layers of the epidermis. It is suggested that melanoprotein molecules may act as semiconductors and that transmission by these semiconductors of the electrons of melanoprotein molecules that have been activated by aborded light may induce immediate pigment-darkening. Histochemical determinations in punch-biopsy specimens taken from areas of skin irradiated with long-wave uv and visible light revealed newly formed, active tyrosinase and newly formed melanin granules, indicating that new melanin was being formed. Ultraviolet irradiation appeared to cause cellular injury that initiated increased synthesis of proteins and other structures within the cell. Presumably, augmented synthesis of melanosomes and tyrosinase and increased formation of melanin granules are integral processes in the formation of new melanin. (BBB)

43509 MORPHOGENESIS OF THE CELLS AT SEVERAL NUCLEI BY THE ACTION OF X RADIATION. STUDY IN CONTRAST OF PHASE ON THE ERYTHROPOIETIC CELLS TO THE LIVING STATE. Rondanelli, E. G.; Trenta, A.; Magliulo, E.;

Vannini, V.; Gerna, G.; Carosi, G. (Univ., Pavia, Italy. Univ., Bologna). Exp. Cell Res., 47: 222-8(Aug. 1967). (In French).

The formation of multinucleated erythropoietic cells was studied by means of phase-contrast cinemicrography of irradiated spleen cultures of Triton Molge vulgaris L. Giant cells with three or more nuclei were formed after mitotic arrest in metaphases, anaphases and telophases in which chromosomes were arranged in three or more groups and cytokinesis failed to divide the cells. The role of lesions of mitotic apparatus in the formation of multinucleated cells is emphasized. (auth)

43510 HYPERPLASTIC LESIONS OF SPRAGUE-DAWLEY RAT MAMMARY GLANDS AFTER X IRRADIATION. Faulkin, Leslie J. Jr.; Shellabarger, Claire J.; DeOme, Kenneth B. (Univ. of California, Davis. Univ. of Michigan, Ann Arbor. Univ. of California, Berkeley). Contract PH 43-64-579. J. Nat. Cancer Inst., 39: 449-58(Sept. 1967).

X irradiation, that produced mammary tumors in Sprague-Dawley rats, also produced hyperplastic lesions of the mammary gland. These lesions were similar morphologically to the preneoplastic lesions of the mouse mammary gland and were more numerous in x-irradiated rats than in animals of comparable age that were not exposed to irradiation. The lesions were more frequent as the time after irradiation increased in both irradiated and nonirradiated rats, however, the rate of increase was greater in the irradiated animals. The hyperplastic lesions induced in the rat mammary glands were not shown to be preneoplastic. However, the greater number of lesions encountered under conditions that increased the incidence of tumors is suggestive information. (auth)

43511 THE BEHAVIOR OF AUTOLOGOUS THYROGLOBULIN IN THE CIRCULATION OF RABBITS IMMUNIZED WITH EITHER HETEROLOGOUS OR ALTERED HOMOLOGOUS THYROGLOBULIN. Weigle, William O.; High, Gloria J. (Scripps Clinic and Research Foundation, La Jolla, Calif.). J. Immunol., 98: 1105-14 (June 1967).

The effect of radioiodine injected into normal rabbits and rabbits with primary immune thyroiditis was studied. Injection of adequate doses (3.3 to 6.3 mCi) of ^{131}Na into iodine-deficient but otherwise normal rabbits resulted in disruption of thyroid structure with release of ^{131}I-thyroglobulin into the circulation. In these rabbits, the ^{131}I-thyroglobulin was eliminated at an exponential rate with a half-life of 2.3 days. The release of autologous ^{131}I-thyroglobulin in rabbits previously immunized with either arsanil-sulfanil-thyroglobulin (homologous) or a heterologous thyroglobulin caused a secondary stimulation resulting in an immune elimination of the ^{131}I-thyroglobulin and production of antibody to native rabbit thyroglobulin. Complexes formed between the circulating ^{131}I-thyroglobulin, and the newly synthesized antibody deposited along the glomerular basement membrane of the kidney; this resulted in mild glomerular inflammatory changes and proteinuria. (BBB)

43512 PRODUCTION OF TOLERANCE IN IMMUNIZED MICE AND THE EFFECTS OF IMMUNOSUPPRESSION. Claman, Henry N.; Bronsky, Edwin A. (Univ. of Colorado, Denver). J. Allergy, 38: 208-14(Oct. 1966).

Effects of whole-body x irradiation and hydrocortisone on tolerance to a protein antigen were studied. Tolerance to bovine gamma globulin (BGG) in mice previously immunized with bentonite-BGG was produced by serial injections of soluble BGG. Larger doses of BGG were more effective in creating tolerance than were smaller doses. A single injection of soluble BGG in immunized mice increased the titer of hemagglutinating antibody. Both hydrocortisone and whole-body x irradiation, used as immunosuppressive agents, facilitated the development of tolerance. An x-ray dose of 600 R together with a high dose of soluble BGG produced no greater tolerance than a high dose of BGG alone, but 600 R with a dose of BGG produced considerably more tolerance than a low dose of BGG alone. The 600-R dose lessened the antibody responses to a first challenge with bentonite-BGG on day 38, and so a second challenge was done on day 53. By day 60, the inhibition of antibody production in normal mice by 600 R, given on day 11, had disappeared. The concept that the production of tolerance in immunized mice by repeated antigen injections involves an initial period of increased immunization before tolerance is reached is discussed. (BBB)

43513 INDIRECT EFFECT OF IRRADIATION ON EMBRYONIC DEVELOPMENT. IV. LETHAL EFFECTS OF MATERNAL IRRADIATION OF FIRST DAY OF GESTATION IN THE RAT. Brent, Robert L.; Bolden, Brooker T. (Jefferson Medical Coll., Philadelphia). Proc. Soc. Exp. Biol. Med., 125: 709-12(July 1967).

An attempt was made to determine whether there is a maternal influence involved in the lethality of rat ova irradiated on the first day of pregnancy. It was demonstrated that 150 R whole-body x irradiation was no more deleterious than irradiation of the pregnant abdominal reproductive organs in rats. Therefore, it was concluded that there is no maternal effect due to irradiation of maternal structures other than abdominal reproductive organs at this stage of gestation and dose of irradiation. If a maternal effect exists it may be due to oviduct irradiation or it may be present with higher doses of irradiation. Irradiation with 150 R on the first day of gestation in the rat did not increase the incidence of exencephaly or gross congenital malformations and did not result in fetal growth retardation. These facts and their significance reinforce the discrepancy in the incidence and type of malformations induced in the mouse and rat following irradiation on the first day of gestation. Although irradiation of the mouse during the preimplantation period produces a phenomenon referred to as whole-litter resorptions, this does not occur in the rat. Thus, the exencephaly and the whole-litter resorptions are produced by irradiating the preimplanted mouse embryo, but do not occur following irradiation of the preimplanted rat embryo. These variations in species response must be explained before attempting to apply any of these data to the human. (auth)

43514 EXPERIMENTAL EOSINOPHILIA. IX. EFFECTS OF IMMUNOSUPPRESSIVE AGENTS ON EOSINOPHIL CELL RESPONSES. Cohen, Sheldon G.; Kostage, Stephen T.; Rizzo, Angelo P. (Veterans Administration Hospital, Wilkes-Barre, Pa.). J. Allergy, 39: 129-38(Mar. 1967).

Experiments were designed to study the mechanism of eosinophilia developing within a few hours after primary antigen exposure in the guinea pig. X-irradiation, chloramphenicol, and colloidal ThO_2 (Thorotrast) were given to suppress different components of the immune response. Of these agents the efficacy of x radiation (500-R, whole-body) and chloramphenicol treatment procedures in suppressing antibody formation after secondary antigenic stimulation was demonstrated. Eosinophil cell infiltrations into lymph nodes regional to subcutaneous foot pad sites of injected bovine γ-globulin and of corresponding soluble antigen-antibody complexes were quantitated in fixed tissue specimens at 6- and 24-hr intervals after administration. Significant differences were not observed in mean cell counts between untreated animals, those given Thorotrast for reticuloendothelial system (RES) blockade, or those treated with cytotoxic and effective immunosuppressive agents. These results favor the explanation that the eosinophilia was not dependent upon an invoked antigen-antibody reaction. A pattern of prolonged eosinophil cell responses was demonstrated in guinea pigs given Thorotrast for RES cell blockade and functional impairment. It is suggested that the eosinotactic effects of foreign species of γ-globulins may be a function of their state of molecular aggregation. (BBB)

43515 A STUDY OF THE INTERRELATIONS BETWEEN IONIZING RADIATIONS AND IMMUNIZATION WITH THE LIVING VACCINE (BCG). I. EXPERIMENTAL RESEARCHES OF X-RAY EFFECTS ON THE VACCINAL PROCESS CONSECUTIVE TO BCG VACCINATION. Nestorescu, N.; Botez, V.; Paraschivescu, M.; Gheorghiu, M.; Roman-Miron, S.; Ciplea, A. G.; Benes, S. Arch. Roum. Pathol. Exp. Microbiol., 24: 659-88(1965). (In Romanian).

Investigations were performed on 240 tuberculin-negative guinea pigs divided into six groups and exposed to single x radiation doses of 171 R. During a 30-day interval, the authors followed the evolution and duration of the local reaction to BCG vaccine, allergy dynamics subsequent to immunization, the influence of irradiation on the residual virulence of the BCG strain of M. tuberculosis, and the influence of vaccination on radiation sickness. The authors assume that the influence of radiation on the BCG vaccination consists in a shortening of the duration of the vaccinal lesion, and a certain reduction in the post-vaccinal tuberculinic allergy. The rate of bacteria multiplication in the liver and spleen was higher when vaccination was performed during evolutive radiation sickness and lower when immunization was carried out at intervals closely preceeding exposure. More severe and more extensive specific lesions in the organs of irradiated guinea pigs were recorded. (TSS)

43516 RADIATION AND SHOCK. J. Amer. Med. Ass., 200: 885(June 5, 1967).

Twelve radiation accidents that resulted in death of six persons are briefly reviewed, with attention to the postirradiation symptoms that developed. The importance of careful control of handling radioactive material is emphasized by the nature of the accidents at Los Alamos in 1958 and in Rhode Island in 1964. Both criticality accidents occurred during the recovery and purification of ^{235}U derived from nuclear reactors and related activities. In both accidents, the operators received lethal doses of radiation, the Rhode Island victim receiving the highest whole-body neutron-γ radiation dose (8800 rad) in human experience. The 3 major mechanisms of death in humans after lethal radiation exposure

are discussed: hematopoietic failure, gastrointestinal mucosa loss, and central nervous system disease. How these syndromes are related to the size of the radiation dose is explained. Detailed pathologic findings in the Rhode Island victim in comparison with those of the Los Alamos patient showed that the brain damage seen in animals exposed to high radiation doses does not develop in man. In both cases, massive peripheral interstitial edema, cavitary effusions, random organ edemas, and inflammation of the meninges, myocardium, and pancreas indicated that widespread vascular damage is the primary radiation lesion underlying the hypotensive shock and rapid death within 2 days. The vascular radiation subsyndrome must be considered as a mojor mode of death within the acute radiation syndrome concept. The cerebral symptoms shown terminally by these 2 victims were ascribed to cerebral anoxia that resulted from vascular inflammatory changes in the brain, myocardium, and rest of the body. (BBB)

43517 SPECIFIC TRANSPLANTATION ANTIGENS OF MOUSE SARCOMAS INDUCED BY ADENOVIRUS TYPE 12. Sjoegren, H. O.; Minowada, J.; Ankerst, J. (Karolinska Institutet Medical School, Stockholm). J. Exp. Med., 125: 689-701(Apr. 1, 1967).

A specific isograft resistance against three different mouse adeno 12 sarcomas was demonstrated in mice treated with 4 to 8 doses of viable or x-ray-killed adeno 12 mouse tumors. Whole-body x ray irradiation with 350 R 24 hr previous to the test challenge did not abolish the resistance, indicating that it was due to a true anamnestic immune reaction. This was further proven by the finding that similar treatment with tumors of other origin did not induce any immunity, nor did the treatment with adeno 12 tumor material induce any immunity against two neoplasms of Schmidt-Ruppin-Rous viral origin. A previous report that adeno 12 infection leads to a specific transplantation immunity was confirmed. When the specificity of this virus-induced immunity was studied it was discovered that besides adeno virus type 12, type 7 and probably type 18 also gave the same type of resistance while adenovirus type 5 did not. A contamination of the adeno 7-infected mice with adeno type 12 was excluded by testing pooled sera from these animals for anti-adeno 12 complement-fixing or hemagglutination-inhibiting antibodies. (BBB)

43518 NEUROPATHY FOLLOWING IRRADIATION. AN UNUSUAL LATE COMPLICATION OF RADIOTHERAPY. Maruyama, Yosh; Mylrea, Murray M.; Logothetis, John (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 216-19(Sept. 1967).

A patient with Hodgkin's disease developing radiation neuropathy, involving the brachial plexus, as a late consequence of orthovoltage radiation therapy is described. Peripheral nerves are radioresistant to acute irradiation, but are susceptible to delayed and secondary alterations. (auth)

43519 BIOLOGICAL EFFECTS OF INTENSE LIGHT. Rich, John (C. A. Parsons and Co., Ltd., Newcastle upon Tyne, Eng. International Research and Development Co., Ltd., Newcastle upon Tyne, Eng.). Ann. Occup. Hyg., Suppl., 13-22(July 1967).

The biological importance of sunlight is emphasized and a brief review is made of the physiological and pathological effects of wavelengths from 2000 to 10,000 Å. These effects suggest that sources of light brighter than sunlight are likely to be damaging to biological materials. Experience with successively brighter artificial light sources has confirmed this, most recently with the laser. Examples are quoted of effects from ruby and neodymium pulsed laser beams and helium–neon continuous working lasers on various biological preparations and intact organisms in vitro and in vivo. Reference is made to tentative applications in biology and medicine. Attention is drawn to the general resemblance of any damage sustained to that due to heat. Thresholds of damage are briefly considered and possible effects from mechanisms other than heat are discussed. Brief comment is made on the hazards and their relation to the biological uses of lasers operating in the light range. (auth)

43520 EFFECTS OF HEAVY MEDIASTINAL X-IRRADIATION ON SEX-SPECIFIC HISTOCOMPATIBILITY. Maruyama, Y.; Barclay, T. J. (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 944-7(Aug. 1967).

Heavy doses of localized x irradiation were delivered to the thymic region in an attempt to destroy the capacity of adult female mice to reject male skin isografts. Destruction of this capacity was observed following high doses but was associated with a high mortality. Morphologic destruction of the gland was observed in animals failing to react to the Eichwald-Silmser phenomenon. (auth)

43521 ACUTE RADIATION INJURY TO THE EYE IN THE ADULT AXOLOTL (SIREDON MEXICANUM). Brunst, V. V. (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 948-55(Aug. 1967).

The anterior portion of the head in 15 adult axolots (Siredon mexicanum) was x irradiated with 30,000 R, a lethal dose; 5 animals served as untreated controls. Most of the irradiated animals died 8 to 10 days after irradiation, and were fixed for histological examination when they were dying or very soon after death. One animal was fixed 7 days, another 11 days, and a third 12 days after irradiation. Despite the brevity of the time after irradiation, injury to the eye was very great, indicating that the latent period was very short in this study. As was expected, the corneas were damaged in 100 per cent of the animals. The substantia propria was generally much thicker and was stratified. In all cases, the corneal epithelium disappeared completely and was replaced with very thick abnormal skin epithelium, which had cells with abnormally large nuclei, contracted pigment cells, and very large Leydig cells. Damage to the retina was also great. The rod-and-cone layer completely disappeared in almost all cases; only in a very few cases could remnants of this layer be observed in some areas. The nuclear layers of the retina were more or less disorganized, and contained abnormally large nuclei in some cases but many pycnotic nuclei in most cases. The number of cells was greatly reduced. Entirely unexpected was the observation that in all irradiated eyes, despite great damage to the cornea and retina, the lenses were completely normal. This observation shows that large doses of x radiation can produce ocular effects that are qualitatively different from those of smaller doses. (auth)

43522 MITOTIC DELAY AFTER FRACTIONATED IRRADIATION OF AUTOTRANSPLANTS OF A SPONTANEOUS MOUSE TUMOR. Seydel, H. Gunter (Univ. of Maryland, Baltimore). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 938-43 (Aug. 1967).

Tumors were excised from mice carrying small spontaneous mammary adenocarcinomas, and tumor fragments of 1 to 3 mm^3 were implanted in the flanks of the same animal. When the transplants reached approximately 10 mm diameter they were exposed to 1, 2, 3, 4, 5, 10, and 15 doses of 660 R x radiation. The tumors were removed at intervals of 2 to 12 hr after the last irradiation and prepared for histological examination for mitosis. The mitotic index was compared with that of transplants from unirradiated animals. The data indicate a rapid drop of the mitotic index after exposure to a single dose of radiation. Data are presented on mitotic delay and recovery time after exposure to various doses of radiation. (C.H.)

43523 THOROTRAST INDUCED CHONDROSARCOMA OF THE AXILLA. Schajowicz, Fritz; Defilippi-Novoa, C. A.; Firpo, C. A. (Italian Hospital, Buenos Aires). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 931-7(Aug. 1967).

A case of chondrosarcoma of the axilla in a 38 year old male with secondary invasion of the scapula is reported. This was caused by a paravasal injection of thorotrast, some 22 years previously. The difficulties of arriving at a clinical and histologic diagnosis are described, as only through biophysical methods was this obtained. There are only slightly more than 60 cases reported in the literature where the etiopathogenic relationship between the injection of this radiopaque substance, with its radioactive effect, and the appearance of a malignant tumor following a long period of latency (12 to 29 years) is confirmed. (auth)

43524 RADIATION INDUCED BONE SARCOMAS. REPORT OF FIVE CASES. Castro, Leonidas; Choi, Sung Ho; Sheehan, Francis Richard (Roswell Park Memorial Inst., Buffalo). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 924-30(Aug. 1967).

It is well known from both clinical and experimental study that ionizing radiation is capable of producing severe damage to bone, occasionally with the formation of bone tumors. Nevertheless, the production of a sarcoma is a very rare sequel to radiation therapy. The case history is presented for 5 cases of bone sarcoma, presumably induced by x radiation: 3 cases occurring as a result of irradiation for carcinoma of the cervix, 1 in the chest wall radiation field for treatment of metastatic Wilms' tumor, and another case of sarcoma of the maxilla following irradiation of the orbit for retinoblastoma. The medical literature reviewed indicates that a total of 93 cases of bone sarcoma following radiation therapy have been reported. Of these, only 3 occurred in the pelvic bones as a result of radiation therapy for carcinoma of the cervix. The literature on this subject is reviewed and the pathogenesis is discussed. (auth)

43525 HUMAN SKIN RESPONSE TO RADIATION THERAPY WITH HIGH-PRESSURE OXYGEN AT 30 PSIG. Parker, R. G.; Wootton, P.; Rowe, J. W. (Univ. of Washington, Seattle). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 100: 920-3(Aug. 1967).

Cobalt-60 teletherapy with high pressure oxygen at 30 psig (pounds per square inch gauge) given in conventional dose-time-fractionation patterns resulted in moderate to marked skin reactions in 18 patients. Under the conditions described, the site of maximum absorbed dose of the ^{60}Co beam shifted toward the absorber surface, thus residing in the site of maximum skin sensitivity and providing a physical basis for the observed skin reactions. Documentation of a biologic augmentation of radiation-responsiveness of skin was difficult. Using single-increment doses of 300 KV peak roentgen rays and oxygen at 30 psig, no oxygen augmentation of the reaction of the skin of the human thigh was noted during the initial 6 week interval following the test dose. However, after this 6 week interval, the oxygenated test site reactions were greater than the air control in 8 of 13 patients. This differential persisted for several weeks and then became imperceptible. The basis or significance of this observation is unknown. It is of clinical importance that there was no untoward change in the treated tissue volumes of these same patients. (auth)

43526 AUGMENTATION OF BIOELECTRIC ACTIVITY BY GAMMA IRRADIATION. **Kaack, B. (Univ. of Notre Dame, Ind.). Amer. J. Physiol., 213: 625-8 (Sept. 1967).**

Gamma irradiation of isolated nerves is capable of enhancing the ability of the nerve to conduct impulses before it destroys this ability. This enchancement of bioelectric activity manifests itself as an increase in amplitude of the spike potential and an increase in conduction velocity. The activity of the cell bodies in the ganglion is necessary for maximal enchancement. The effects are attributed to the action of gamma rays on the nerve itself rather than to other indirect effects. (auth)

43527 EXPERIMENTAL RADIOISOTOPE IRRADIATION OF RENAL ALLOGRAFTS IN DOGS. **Bonte, Frederick J.; Peters, Paul C.; Johnson, Donald; Webb, Watts R.; Stembridge, Vernie A. (Univ. of Texas, Dallas). Int. J. Appl. Radiat. Isotop., 18: 689-95 (Oct. 1967).**

Rejection of a canine renal allograft is accompanied by infiltration of the graft with lymphocytes and plasmacytes. External beam irradiation of the graft at intervals after transplantation has been employed to lower the population of these invading cells, and, in several laboratories, has been found to prolong host and graft survival. A series of experiments is described in which chronic, low-dose irradiation of canine renal allograft was attempted by causing ^{203}Hg to be deposited in graft renal tubular epithelium. Graft and host survivals were prolonged beyond control values in a few animals, but the general technique is not as yet adaptable to human renal-transplantation problem. (auth)

43528 RADIATION MYOPATHY. **Faes, M. H.; Rosselle, N. (Univ., Louvain, Belg.). Lancet, 1: 1231 (June 3, 1967).**

The histologic appearance of striated muscle after irradiation closely resembles that of muscle dystrophy or myopathy. The affected individual muscle cells that undergo hyaline degeneration are distributed haphazardly among the normal ones, and patches of monocytic infiltration are seen. Whether these histologic similarities are reflected by similar electrophysiological responses was investigated by γ irradiation of guinea pigs on the right hind-limb with ^{60}Co at doses of 200, 400, 800, 1600, 3200, and 6400 R. Except for those receiving the highest dose, most animals survived more than five months. They were examined electromyographically at regular intervals. From the first weeks on, EMG disturbances were noticed after a delay that was longer for the lower doses. The main anomalies were similar to those seen in myopathies. Disturbances caused by irradiation in muscle resembled those found in myopathy from the electrophysiological aspect also, thus justifying the use of the term radiation myopathy. These alterations seemed to precede the clinical alterations and thus may lead to earlier evaluation of radiation damage in muscle tissue. (BBB)

43529 HISTOLOGIC AND HISTOCHEMICAL CHANGES IN THE HEMATOPOIETIC TISSUES OF RATS AFTER TOTAL BODY X-IRRADIATION. I. THE SPLEEN. **Wang, Sheng-yuan; Ma, Wen-chao (Medical Coll., Peking). Chiek Pou Hsueh Pao, 8: 162-82 (1965). (In Japanese).**

Sixty-two adult rats were employed; eight of them served as controls and the remainder were exposed to whole body x irradiation in a single dose of 500 R. The animals were sacrificed at intervals of 2, 6, 12 hours and 1, 3, 6, 10, 20, 30 days after irradiation. Specimens of the spleen were obtained from both the experimental and control groups for histological and histochemical examinations. The data indicate that: A marked decrease in the spleen size and in the number of its Malpighian corpuscles, and a severe destruction of its architecture with an extensive necrosis of lymphocytes, occurred within 24 hours after irradiation. Regeneration began on the 6th day and the spleen became almost normal at the end of the 30th day. Among the various cell-types of the spleen, the radiosensitivity was highest in the lymphocytes and lowest in the plasma cells. The reticular cells were apparently injured during the early stage after irradiation, though they belonged to the radioresistant series. The decrease in staining intensity of both desoxyribose- and ribose nucleic acids of the spleen started as early as 2 hours after irradiation and continued to reach its maximum in a period of 1 to 3 days. This result was produced not only by the depletion in cell population, but also by the decrease in nucleic acid content of individual cells. A marked increase in the activity of nonspecific alkaline phosphatase and adenosine triphosphatase occurred within 24 hours and it returned gradually to normal from the 3rd day to the 10th day after irradiation. There was no significant change in the amount of protein-bound SH-groups of various cell-types of the spleen in each post-irradiation period. No difference was found in the changes produced by irradiation between the animals fed with normal diet and those fed with phospholipides in addition. (auth)

43530 PROCEEDINGS OF THE SECOND INTERNATIONAL SYMPOSIUM ON BASIC ENVIRONMENTAL PROBLEMS OF MAN IN SPACE, PARIS, 14–18 JUNE 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967. 539p. $34.50. (CONF-650668).

Separate abstracts were prepared on six papers. One paper was abstracted previously and appeared as NSA 20: 22623. Fifty-eight additional papers discuss various aspects of environmental problems encountered during space flight. (C.H.)

For abstracts of individual papers see: 43390, 43391, and 43531–43534.

43531 SOME PROBLEMS OF ECOPHYSIOLOGY. Sissakian, N. M. (Academy of Sciences, Moscow). pp 49–60 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14–18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967.
See CONF-650668.

Space physiology, or ecophysiology, is defined as a complex of biological sciences that study peculiarities in vital processes and behavior of terrestrial organisms exposed to space flight environments. It is pointed out that studies on space physiology involve an understanding of the unique reactivity of living organisms to environmental stresses, together with data on their tolerance limits. The environmental conditions to be studied can be divided into factors inherent in outer space such as vacuums, cosmic radiations, solar radiations, and low temperature, and factors related to the artificial atmosphere in the spacecraft, such as gas composition, pressure, temperature, acceleration, vibration, and weightlessness. Difficulties encountered in simulating space flight conditions are discussed. Results are summarized from a number of studies on fundamental aspects of space physiology at the cellular and animal level. It is pointed out that during the 5-day flight of the Vostok-5 Soviet spacecraft one of the cosmonauts performed an extra-vehicular excursion in space. No changes were noted in the health of the two cosmonauts either during or after the mission. Paramount importance was attached to studies of performance efficiency and of the mechanics of movement of the man outside the spacecraft. It is concluded that a vast amount of information on the response of man to the environment found in space is available for the use of designers of spacecraft and the further progress of astronautics. (C.H.)

43532 BIOECOLOGICAL AND BIOMEDIAL MONITORING FOR ADVANCED MAN IN SPACE PROJECTS. Clemedson, Carl-Johan (Medical Board of the Armed Forces, Stockholm). pp 61-79 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14–18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967.
See CONF-650668.

Since the physical and mental integrity of the astronaut is of decisive importance for his capability and efficiency and, therefore, also for the success of the mission, monitoring of a number of bioecological and biomedical parameters during the space mission is needed. Some of the most pertinent problems regarding the health surveillance of a space crew during mission are reviewed with emphasis on the philosophy behind the recommendations as to which parameters should be measured. The parameters to be monitored are divided into two groups, viz., bioecological, which comprise external and internal environmental factors pertaining to the space vehicle and space suit, and biomedical, comprising physiological and mental factors or in other words, the interior milieu of the astronaut. Of bioecological parameters, space ambient ionizing radiations and cabin atmosphere factors such as temperature and humidity, oxygen, carbon dioxide, and trace contaminants, as well as noise and vibration are dealt with. The physiological and psychical factors discussed

are mainly the function of cardiovascular, respiratory and central nervous systems, awakeness and alertness, body temperature, and biochemical and immuno-biological problems. Some points concerning data collecting and processing are cursorily discussed. (109 references.) (auth)

43533 INTERACTION OF RADIATION AND OTHER ENVIRONMENTAL STRESSES IN BIOLOGICAL SYSTEMS. Tobias, C. A.; Amer, N. M.; Ashikawa, J. K.; Lyman, J. T.; McDonald, L. W.; Slater, J. V.; Sondhaus, C. A.; Todd, P. W. (Univ. of California, Berkeley). pp 141-58 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14–18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967.

See CONF-650668.

The cellular and molecular effects of heavily ionizing radiation are studied in order to understand radiobiological aspects of present and past life on the planets and to provide a basis for assessment of radiation hazards of manned space flight. Since solar flares consist of high energy protons and alpha particles, the Van Allen belt has many protons and since many heavier nuclei strike the top of the atmosphere, their effects are studied in the laboratory with the aid of accelerated protons, He, Li, B, C, N, O, Ne, and A nuclei. In the Berkeley HLAC monoenergetic beams of about 8.4 MeV per nucleon are available. At the cellular level, the biological effects depend strongly on the linear energy transfer (LET) of the particles; this is allowed to vary between 0.2 keV/micron. The effectiveness of a single particle crossing a cell increases with increasing LET for enzymes, phage particles, bacterial spores, yeast cells, and mammalian cells. There appear two types of radiobiological effects which are clearly discernible. The first is an oxygen dependent effect, probably due to single ion pairs, delta rays, and small clusters. A single such event is able to inactivate a phage particle or enzyme molecule, but several of these events cooperate to inactivate a mammalian cell. The efficiency of this effect, as measured by a cross section, increases proportionally with LET until saturation is reached. Cellular injury caused by this effect is at least partially reversible. The second type of effect, probably due to the heavily ionizing core of particle tracks is almost dependent of ambient oxygen concentration. The cross section for this effect increases as the square of LET until saturation occurs, so that this direct effect appears to be the major cause of lethality for mammalian cells at high LET. Though this effect is only slightly (if at all) modified by oxygen it is shown that high concentration of glycerol in yeast protects by a factor of two even at the highest LET tested. Glycerol protection has been shown for mammalian cells as well. Low LET radiation effects are in part reversible, as shown for mammalian cells in yeast. Dark recovery of this type can occur for the highest LET particles in diploid yeast. There is also a synergism of radiation and high temperatures at the cellular level; this effect is at least in part due to an adverse effect of high temperatures on the cytochrome system, which is needed for post irradiation recovery. The sensitivity of cells for heavy ions at high LET increases nearly in proportion to the nuclear area of the cells, though ploidy is a modifying factor. The effects of protons, alpha particles, and heavier ions have also been studied on mammals. The solar flare dose distribution as well as cellular sensitivity has directed attention to the more rapidly proliferating tissues as limiting acute radiation tolerance: epithelial tissue, bone marrow, and tissues of reproductive organs. It was demonstrated that acute doses of 730 MeV protons and 900 MeV alpha particles cause a predominance of the intestinal syndrome in mouse lethality, with the hematological syndrome less marked. Data were obtained on the increasing sensitivity of mouse hair follicles with LET and studies on the skin of rabbit ear confirmed the ideas with respect to increasing sensitivity of skin spithelium. Nystagmus effects were demonstrated, following bilateral 500 RAD localized proton radiation of the rabbit vestibular apparatus. Vestibular effects of radiation may attribute to the vertigo of radiation sickness. It is concluded that tests of synergism between radiation effects on intestinal epithelium, vestibular system, weightlessness, and acceleration are essential for full evaluation of the response of astronauts in space environment. (20 references.) (auth)

43534 EFFECTS OF HIGH FREQUENCY ELECTROMAGNETIC FIELDS ON THE UPTAKE OF METHIONINE ^{35}S BY THE SPLEEN AND LIVER OF MICE. Miro, L.; Loubiere, R.; Pfister, A. (Centre d'Enseignement et de Recherches de Medecine Aeronautique, Paris). pp 289-97 of Proceedings of the Second International Symposium on Basic Environmental Problems of Man in Space, Paris, June 14–18, 1965. Bjurstedt, Hilding (ed.). Vienna, Springer-Verlag, 1967. (In French).

See CONF-650668.

In research work on the biological effects of microwaves and magnetic fields, little attention has been given to the cellular and metabolic results. However, as previous studies seemed to indicate that an excitation of the cellular metabolism occurs in the liver and spleen, the present study was made. The experiments were carried out on two groups of mice. The first group was exposed during 150 hours to a high frequency electromagnetic field and the second was used as a control group. After radiation, an intra-peritoneal injection of ^{35}S-methionine was given to each animal. Sixteen hours later, the mice were decapitated, the autopsy was made, and the organs (liver and spleen) removed and prepared according to the classical techniques. Histo-autoradiographic and histophotometric techniques were used to determine the uptake of ^{35}S-methionine in the liver and, separately, in the germinative centers, the reticulo-histiocytic areas, and the red pulp of the spleen. The presence of amino acids is much greater in the animals exposed to the high frequency magnetic fields than in the control group. A statistical analysis of the results shows that the difference is extremely significant. This observation, which proves that there is an increase of protein synthesis in the liver and spleen, combined with the anatomo-pathological aspects of reticular hyperplasia found elsewhere, indicates that the high frequency magnetic fields have an exciting effect on the reticulo-histocytic system. (auth)

43535 EFFECTS OF X RAYS ON THE DEVELOPMENTAL BIOLOGY OF HETERAKIS GALLINRUM AND ON THE PATHOGENICITY OF HISTOMONAS MELEAGRIDIS. Ostlind, Dan Albert. Manhattan, Kansas, Kansas State Univ., 1966. 267p. Thesis.

Experiments were conducted to study the effects of x irradiation on the development of Heterakis gallinarum and on the pathogenicity of its associated symbiont, Histomonas meleagridis. Embryogenesis was retarded by x rays. The amount of retardation was dependent upon the radiation dosage and age of the eggs at the time of irradiation. Data were taken to investigate the ability of irradiated eggs to transmit blackhead. No conclusions were reached because of the extreme variability in results although it appeared that high dosages decreased the incidence of blackhead. This may have been an indirect effect of x rays by merely reducing the survival of worms either entering or prior to entering the ceca. A nonpathogenic strain was isolated from chickens but it was not believed to be the result of irradiation. Exposure of unsegmented eggs to dosages up to 64,000 R did not affect infectivity of the females. However, male infectivity was decreased by 30,000 R but not 16,000 R in similar experiments. Irradiation of larvated eggs with x ray dosages up to 32,000 R had no effect on female infectivity. Male infectivity in similar experiments was decreased by 4,000 R. Higher dosages (45,000 R) eliminated all males while 32,000 R did permit the survival of a few. Heterakid sex ratios were affected by 30,000 to 64,000 R dosages when eggs were exposed in the unsegmented condition. Smaller dosages (4,000 to 8,000 R) produced similar results when larvated eggs were exposed. The bilateral cecal distribution of heterakids was unaffected by irradiation of either unsegmented or larvated eggs. As previously demonstrated more worms were found in the left cecum than in the right. Growth rates, based on the length of the recovered nematodes, were reduced by high dosages (64,000 R) when unsegmented eggs were exposed and by dosages of 4,000 R and up when larvated eggs were irradiated. Morphologically, exposure of unsegmented eggs resulted in no effects except for an increase in the number of females showing abnormal eggs in the high dosage (64,000 R) groups. Abnormalities that increased with increased dosages, given to larvated eggs, were abnormal distribution of caudal papillae, abnormal eggs, abnormal spicule, immaturity, reduced number of eggs, retarded reproductive organ development (female), without spicules, and absence of one spicule. Chickens developed a weak acquired immunity against Heterakis gallinarum following a single infection with normal worms. The resistance developed from a single infection with irradiated eggs (65,000 or 45,000 R) was almost negligible. Generation studies to investigate possible latent irradiation effects were carried out through the F_3 generation for both the exposure of unsegmented or larvated eggs. Except for increased embryogenic retardation in the F_1 generation of the 64,000 R group and increased variability of inactivity, no other latent effects were observed after exposure of unsegmented eggs. A similar F_1 generation embryogenic retardation was found in the 4,000 R group following exposure of the larvated eggs that persisted through the F_3 generation. The infectivity of the 2,000 R group generations was more variable than either the control or 4,000 R groups. Infectivity of the 4,000 R generations was lower than that of the controls. In vitro irradiation of Histomonas meleagridis appeared to increase the growth rate if low dosages (25 to 60 kR) were used. High dosages (100 to 150 kR) had little effect on in vitro or in vivo growth rates. Very high dosages (150 to 200 kR) appeared to retard in vitro growth rates. Histomonads exposed to dosages above 150 kR were not given to turkeys. Irradiation results on H. meleagridis were highly variable, possibly due to associated bacteria in the culture tubes. Pathogenicity ap-

peared to be relatively unaffected. However, high radiation dosages increased the time required for observation of yellow droppings and/or death. Liver lesion variation was noted but not associated with any particular roentgen dosage. (Dissertation Abstr.)

43536 CONDITIONED PUNISHERS ESTABLISHED BY PAIRING WITH X-IRRADIATION AND THEIR EFFECTS ON TWO-BAR RESPONDING IN THE TAMARIN. Whaley, Donald Lee. Gainesville, Fla., Florida State Univ., 1966. 83p.
Thesis.

Two male tamarin monkeys (Tamarinus Nigricollis) were trained to press for orange juice in a Skinner box with two levers. Reinforcement was dispensed on a variable-interval schedule, such that after an average time of 30 seconds had elapsed, a response on either lever resulted in reinforcement. After the animals had been trained to operate on either lever under this schedule, irradiation procedures were begun. Animals were confined in an irradiation chamber twice daily for ten minutes. Either a 10,000 Hertzian wave (Hz) tone or a 15,000 Hz pulsating tone was presented during this time. One of the tones was consistently paired with four minutes of x irradiation at a dose rate of 0.6 r per minute. The other tone was consistently paired with four minutes of 2.4 r x irradiation. After irradiation each day, animals were placed in the experimental chamber for one hour. After one minute of bar press activity a 0.5 second tone was made contingent on each bar press. If the animal did not switch to the other bar, the contingent situation remained for one minute. Switching to the other bar terminated the tone, and allowed the animal another minute of activity until the tone was again programmed. The contingency was made up of five components which were programmed randomly. Four of the components were tones whose frequencies were 5000, 10,000, 15,000, and 20,000 Hz. The fifth condition was no tone, and served the purpose of a comparison measure for the tone-contingent series. Each time a component was presented, switching behavior was recorded. Dependent measures were whether the animal switched to the other lever, the latency before he switched, and the number of responses made before switching. Irradiation was continued for 17 days and then discontinued. After that, seven days of extinction data were collected. Ten days of pre-irradiation data showed no unconditioned effects of the tones on responses, switching behavior, or latencies. After approximately five days of irradiation, the various tone components became differentiated. In general, animals exhibited the longest latencies and the most responses to the no-tone component and the shortest latencies and fewest responses to the two tones which were paired with irradiation. The two remaining tones fell between these two extremes. Separate analyses of variance were done on the latency and response data, in which measures from the two animals were considered for each of the five tone components and across 17 days of irradiation. In the $2 \times 5 \times 17$ analysis for latency data, the main effects of tones and days were significant ($P < .01$). In the response analysis, all main effects were significant, the first factor indicating a difference in response rate between the two animals. Pair-by-pair comparisons were made of the means for each of the five tone components for latencies and responses. It was found that all tones differed significantly from the no-tone component, and that the tone paired with the highest level of irradiation was significantly different from the tones which were not paired. A test for independence between the tone components and the number of switches made by each of the animals was done by means of the chi square statistic. It was found that switching behavior was dependent on the tone component present ($P < .01$). It was concluded that previously neutral tones developed aversive properties by their pairing with x irradiation, and further that the degree of aversiveness was greater with the higher level than with the lower. (Disser. Abstr.)

43537 STUDIES ON X IRRADIATION AND THE NEUROHUMOR: SUBSTANCE P. Christensen, Howard Dix. Los Angeles, Univ. of California, 1966. 219p.
Thesis.

Actions of Substance P in the transmission process and the effect of ionizing radiation on the functioning nervous system were partially elucidated in this study. The general study consisted of the effects of an acute moderate dose of x-radiation on the distribution of Substance P in the central nervous system and small intestine of the rat. Hypothalamic self-stimulation changes in the rat and spectral alterations in spontaneous and evoked activity plus impedance changes in the visual system of the cat were determined after ionizing radiation and Substance P administration. In this initial study, coupling irradiation and Substance P, the following results were obtained. Whole-body (600 R) irradiation increased the concentration of Substance P in the spinal cord of the rat at six hours; the cortex, brain stem, spinal cord at 24 hours; and decreased the concentration in the brain stem, duodenum, and jejunum at nine months postirradiation. Head, but not body, irradiation produced a significant increase in the cortex at 24 hours postirradiation. Electrophoretic and chromatographic studies indicated no alterations in the polypeptide pattern of the extracts. (Dissertation Abstr.)

Radiation Effects on Plants

Refer also to abstracts 43330, 43358, 43407, 43460, and 43519.

43538 ATOMIC IRRADIATION OF GLADIOLUS SEED. Hubbard, Calvin P. (New England Gladiolus Society, Whitinsville, Mass.). Gladiolus, 41: 59-65(1966).

Irradiated seeds of gladiolus from a source in Oak Ridge were planted along with nonirradiated seeds. Earlier and larger percentages of germination were noted for irradiated seeds and seeds originating from bulbs produced by these irradiated seeds for six generations. In the seventh year growth was not as vigorous as in the nonirradiated seeds. Under uniform fertilization schedules, bulbs from irradiated seeds were larger, and germination during the second year from irradiated seeds was 40.44% or four times higher than in nonirradiated seeds. A valuable secondary attribute of seed irradiation was earlier selection or rejection of seedlings. (E.R.B.)

Radiation Effects on Microorganisms

Refer also to abstracts 43519 and 43535.

43539 ULTRAVIOLET ACTION SPECTRA IN ALGOLOGY: A REVIEW. Halldal, Per (Univ. of Umea, Sweden). Photochem. Photobiol., 6: 445-60(July 1967).

The effects of uv radiation of various wavelength on the following features of metabolism of algae are reviewed (with 66 references). Other aspects of photobiology discussed included photoinactivation, photoreactivation, and red far-red response. In considering uv-induced effects it was emphasized that a distinction must be made among the different wavelengths of uv radiation. Near-uv was considered to be the spectral region between 390 and 310 nm; far-uv was between 310 and 190 nm, and vacuum-uv, where no action spectra in algology were performed, was between 190 and 120 nm. In general, it was concluded that near-uv irradiation affected algae in the same manner as visible light. Photosynthesis, growth and development, chloroplast formation, phototactic responses, and induction of polarity and chloroplast movement were nearly all, with few exceptions, stimulated by uv radiation between 390 and 310 nm. Photoreactivation of lesions induced in DNA systems by far-uv also took place in the near-uv region, down to 310 nm. Far-uv irradiation was in its effect much more complex than that of light or near-uv radiation. When exposed to radiation below 310 nm, biological activity was retarded, the lesions being of at least 2 different kinds: either protein destruction, which results in immediate reduction of the biological activity, or lesions in the DNA system. In the latter case the damaging effect was first observed after one or two cell divisions. As an exception, stimulation of growth could be introduced after far-uv treatment. (BBB)

43540 INHIBITION OF GROWTH OF rII MUTANTS OF BACTERIOPHAGE T4 BY IMMUNITY SUBSTANCE OF BACTERIOPHAGE LAMBDA. Tomizawa, Jun-ichi; Ogawa, Tomoko (National Inst. of Health of Japan, Tokyo). J. Mol. Biol., 23: 277-80(1967).

Bacteria lysogenic for various λts phages were induced by uv irradiation, mitomycin C treatment, and heating. They were infected with T4r73, and rII mutant of T4D, in the presence of 0.004M KCN at a low multiplicity and plated on Escherichia coli B. The ability to support the growth of T4r73 of cells lysogenic for 6 independently isolated ts mutants after heating in buffer or in broth was tested. A correlation was noted between the types of ts mutants and their capacity to support the growth of the rII mutant after heating. Treatment of lysogenic cells by uv irradiation or by mitomycin C did not increase the transmission coefficient. These results show that the correlation between the induction of prophage λ and the de-repression of growth of T4rII is poor. Without heating at an early time, most of the cells did not support the growth of either λh or T4r73, and the cells which did support their multiplication increased with the time of incubation. The increase in the fraction of cells supporting multiplication of λh by incubation was almost the same as that of the cells supporting multiplication of T4r73. When the cells were infected after heating, λh and T4r73 always grew. The immune nonlysogenic segregants irradiated by uv light or treated with mitomycin C did not support growth of T4r73. Since the immunity substance participates in the repression of the multiplication of T4rII, the synthesis of immunity substances in cells subjected to a lytic infection of phage λ was studied. The bacteria were uv

irradiated and infected with phage λ. No decrease of the cells capable of supporting T4r$^+$ was noted, indicating that the immunity substance of phage λ is produced even in a lytic infection. (BBB)

43541 CHARACTERISTICS OF BACTERIOCINS PRODUCED BY KLEBSIELLA BACILLI. Maresz-Babczyszyn, Jadwiga; Durlakowa, Irena; Lachowicz, Zofia; Hamon, Yves (Inst. of Immunology and Experimental Therapy, Wroclaw. Pasteur Inst., Paris). Arch. Immunol. Therap. Exp., 15: 530-9(1967).

Forty-nine bacteriocins produced by Klebsiella strains with different biochemical and serologic properties were studied. Differentiation of the bacteriocins based on sensitivity of selected mutants allowed their classification into six groups, which were designated by the letters A, B, C, D, E and F. The bacteriocins of the A, C, D, and F groups had similar biologic and physiochemical properties, but differed serologically. Bacteriocins of the B and E groups differed biologically from the remaining ones, mainly in being incapable of synthesis in liquid media and lack of induction under the influence of uv radiation. (auth)

43542 S–R DISSOCIATION IN SHIGELLA FLEXNERI POPULATIONS. I. THE GENETIC MECHANISM OF DEVELOPMENT OF ROUGH FORMS. Rowinski, Stefan (Inst. of Immunology and Experimental Therapy, Wroclaw). Arch. Immunol. Therap. Exp., 15: 640-51(1967).

Genetic tests on the character of the S → R variation in Shigella flexneri were performed, including the fluctuation, clonal, and replica-plate tests. The results demonstrated spontaneous, clonal origin of R forms, independent of the selection factors. The mutation rate was calculated to be about 10^{-7}. Trials of mutagenic induction (nitrous acid, ultraviolet radiation, colchicine) gave either negative or inconclusive results. (auth)

43543 CAFFEINE AND AMINO ACID EFFECTS UPON TRY$^+$ REVERTANT YIELD IN UV-IRRADIATED HCR$^+$ AND HCR$^-$ MUTANTS OF E. COLI B/r. Clarke, C. H. (Univ. of Edinburgh). Mol. Gen. Genet., 99: 97-108(1967). (In German).

The influence of supplementation of the postirradiation plating medium with caffeine and/or amino acids, on both uv-induced killing and try$^+$ reversion yield, was studied in hcr$^+$ and hcr$^-$ derivatives of E. coli B/r tryptophan auxotroph WWP-2. In hcr$^-$, caffeine caused no enhancement of either killing or try$^+$ revertant yield, but mutational enhancement by supplementation with a low level of tryptophan was noted, and to an even greater effect with tryptophan plus additional amino acids. In hcr$^+$, tryptophan and/or other amino acids caused by enhancement of try$^+$ yield, as in hcr$^-$. Caffeine caused lethal enhancement on several media. There was an apparently straightforward dose enhancement of caffeine, of lethality and try$^+$ revertant frequency, on media containing no, or only, tryptophan. On media containing both a low level of tryptophan and additional amino acids, however, caffeine caused a preferential enhancement of try$^+$ revertant frequency above pure dose enhancement. It is suggested that uv may cause two types of lesion. One type may lead to mutation, and is repaired by both the caffeine-insensitive MFD, and the caffeine-sensitive hcr, dark repair systems. This first type of lesion is protected from repair by the presence of amino acids. The second type of lesion may cause either lethality or mutation, is repaired only by the dark-repair system, and is not subject to protection by an amino acid pool. (BBB)

Radiosterilization and Radiopreservation

43544 IRRADIATION OF MANGOES. I. RADIATION-INDUCED DELAY IN RIPENING OF ALPHONSO MANGOES. Dharkar, S. D.; Savagaon, K. A.; Srirangarajan, A. N.; Sreenivasan, A. (Atomic Energy Establishment Trombay, Bombay). J. Food Sci., 31: 863-9(Nov.-Dec. 1966).

Mangoes (Mangifera indica) were irradiated in various atmospheres with ^{60}Co at a dose rate of 25 Krad/min to doses of 12, 25, 50, 75, 100, and 200 Krad. Extension of storage life of unripe and mature Alphonso mangoes was achieved at an optimum dose of 25 Krad when irradiated under air, nitrogen, or carbon dioxide. Nitrogen atmosphere during irradiation was advantagous in minimizing changes in organoleptic quality, ascorbic acid, and carotenoids, and at the same time allowed the least spoilage of fruit. Judging from skin color and fruit firmness, a six day delay in ripening could be expected in fruits irradiated with 25 Krad under nitrogen or air. Radiation effects on fruit skin were more prominent in terms of inhibition in chlorophyll disappearance and carotenoid formation than in ripening changes in the fruit. Changes in acidity, total and reducing sugars, and starch during ripening of control and irradiated mangoes are reported. A delayed reduction in acidity under the stress of irradiation was seen. Reducing sugars were increased in the irradiated mangoes, although some delay was observed in total sugar formation and starch disappearance. Changes in skin color were not correlated well with the stage of ripening of irradiated mangoes, since fruits at an eating-ripe stage still had green skin. Radiation effects on fruit skin were manifested more prominently in terms of inhibition in chlorophyll disappearance and carotenoid formation than in the ripening changes in the meat of the fruit. The higher fruit pressure of irradiated mangoes, with green skin but ripe meat, was reflected by the hardness of the skin. (BBB)

43545 EFFECT OF FEEDING IRRADIATED ONION TO CONSECUTIVE GENERATIONS OF THE RAT. Van Petten, G. R.; Hilliard, W. G.; Oliver, W. T. (Univ. of Guelph, Can.). Food Cosmet. Toxicol., 4: 593-9(Dec. 1966).

A study was designed to determine whether one-yr feeding of γ-irradiated or nonirradiated onion to consecutive generations of rats would reveal toxic effects not apparent in a previous report. Eighteen second-generation rats of each sex were selected from each of the seven groups used in the previous study and maintained to 25 weeks of age on the same diets as their parents. Third-generation rats were similarly maintained to six weeks of age. Although certain isolated changes in hematology were found during the experiment, extensive analysis of the hematological and pathological data obtained terminally indicated no significant difference between the groups in either generation. It was concluded, therefore, that the feeding of irradiated onion, in amounts considerably in excess of predicted human consumption to two successive generations of rats produces no toxic effect. (BBB)

43546 EFFECTS OF DEVELOPMENTAL STAGE AT THE TIME OF GAMMA IRRADIATION AND TREATMENT WITH INDOLYL-3-ACETIC ACID ON THE STORAGE BEHAVIOUR OF TOMATOES. Mathur, P. B. (Central Food Technological Research Inst., Mysore, India). Int. J. Appl. Radiat. Isotop., 18: 663-5(Sept. 1967).

Studies are described with a view to determining (i) the maximum gamma dose which would not interfere with natural ripening, (ii) the best developmental stage, particularly in relation to the respiratory "climacteric," for irradiation, and (iii) the effect of treatment with indolyl-3-acetic acid to reduce susceptibility to decay of the irradiated fruit. The optimum ^{60}Co gamma ray dose was found to be 75 kR, for subsequent storage at 9° to 10°C and relative humidity 85 to 90%. A dose of 100 kR adversely affected ripening, although decay was controlled. Treatment with the methyl ester of indolyl-3-acetic acid was carried out by dipping the fruits in a 500 ppm solution for 50 mins. Data are tabulated. Irradiation soon after picking resulted in hastening of ripening and decrease in storage life at room temperature. Irradiation at the respiratory pre-climacteric minimum slowed ripening and resulted in increased storage life. Treatment with the hormone resulted in a further slowing of ripening and a further increase of storage life. Data are also given for storage at 9° to 10°C, this representing the optimum storage temperature. (UK)

43547 DEVELOPMENT OF RADIATION-STERILIZED CHICKEN. Heiligman, F.; Wadsworth, C. K.; Phillips, C. E. (Army Natick Labs., Mass.). Food Technol., 21: 108-10 (May 1967).

Various tests have indicated that radiation processed chicken is a satisfactory product and is suitable for use in Army garrison mess hall feeding systems. This report summarizes the results of these investigations and describes recent work leading to the development of a standard process that assures a uniform, acceptable product. Variations in final product were found to be closely correlated with acceptability and preference tests. Most important of the recognized deficiencies in the product were those associated with radiation induced off-color, texture deterioration, and irradiation flavor. Results of experiments on improvements in methods of enzyme inactivation, improvements in packaging techniques, irradiation at low temperatures, and reduction in dose requirements to attain sterility is yielding information that is being used to correct these deficiencies and to improve the acceptability of the product. (BBB)

43548 LONG-TERM EFFECTS OF FEEDING IRRADIATED ONION TO DOGS. Hilliard, W. G.; Oliver, W. T.; Van Petten, G. R. (Univ. of Guelph, Can.). Food Cosmet. Toxicol., 4: 577-83(Dec. 1966).

Clinical, hematological, and pathological observations were made during an 18-month trial in which γ-irradiated or nonirradiated onion was incorporated in the daily diet of beagle dogs to determine whether irradiation imparts toxicity. The dogs received the basic ration containing the equivalent of 25% wet wt onion treated with 20 KRAD of ^{60}Co γ rays. Irradiated onion in the diet produced no clinical or gross pathological changes. A slight degree of anemia was consistently found together with

moderate degenerative changes of testes and ovaries in the onion-fed dogs, but these changes could not be related to the irradiation of the onion. No evidence was obtained to indicate that irradiation changed the characteristics of onion so as to induce toxicity. (BBB)

43549 EFFECTS OF FEEDING IRRADIATED ONION TO RATS AND PIGS. Oliver, W. T.; Hilliard, W. G.; Van Petten, G. R. (Univ. of Guelph, Can.). Food Cosmet. Toxicol., 4: 569-76 (Dec. 1966).

Rats and swine were maintained for 12 and 24 weeks respectively on diets containing nonirradiated or γ-irradiated onion. During this time they were examined clinically and hematologically. Blood samples were collected for biochemical analyses, the animals were autopsied, and tissues submitted to histopathological examinations. The onion was treated with 20.3 KRAD of ^{60}Co radiation. Eight Yorkshire breed pigs, eight weeks old, were maintained on diets containing the equivalent of 25% wet weight of irradiated or nonirradiated onions. Also, 30 male and 30 female four week old Wistar rats were fed similarly. Food consumption, weight gain, pathology, and clinical condition of animals were not changed significantly by inclusion of irradiated onion in the diet. However, hemoglobin levels of control swine and test rats, hematocrit levels in male control swine, and total erythrocyte count in test rats showed statistically significant decreases. These and other discrepancies indicated that more detailed studies of additional species over longer periods of time are required to define the toxicity of irradiated onion. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 44826 and 44902.

43550 METALLURGIYA I METALLOVEDENIE CHISTYKH METALLOV. VYPUSK V. (Metallurgy and Studies of Pure Metals. Volume 5). Emel'yanov, V. S.; Evstyukhin, A. I. (eds.). Moscow, Atomizdat, 1966. 220p.

Most of the 26 papers included on the preparation and properties of pure metals were presented at various conferences during 1963–64. Separate abstracts were prepared for 12 of the papers. (R.V.J.)

For abstracts of individual chapters see: 42953–42956, 43561, 43562, 43635–43637, 43669, 43676, and 43677.

43551 THE ALKALI METALS. An International Symposium Held at Nottingham on 19th–22nd July 1966. Special Publication No. 22. London, The Chemical Society, 1967. 495p. (CONF-660712).

Forty-three papers were presented at the Symposium. Separate abstracts for 23 papers of particular interest in the nuclear field are prepared. One paper was previously abstracted and appears as NSA 20:38856. (UK)

For abstracts of individual sections see: 42876, 42920, 43557, 43573, 43574, 43593–43608, 43628, and 43682.

Corrosion and Erosion

43552 (BNL-50068) HIGH-TEMPERATURE LIQUID-METAL TECHNOLOGY REVIEW. A Bimonthly Technical Progress Review. Volume 5, Number 3. (Brookhaven National Lab., Upton, N. Y.). June 1967. 48p. Dep. CFSTI.

Topics discussed and results presented include: alkali metals evaluation of thermodynamic and transport properties; materials investigation for the SNAP 50/SPUR program; testing of liquid-metal boilers for Rankine-cycle power systems; multitube forced-convection boiler flow stability; characterization of aerosols produced by sodium fires; lithium-boiling potassium test loop; sodium purity requirements; alkali metal two-phase flow investigation; and carbon measurements methods in sodium. (D.C.C.)

43553 (GEAP-5415) THE EFFECT OF CATHODICALLY CHARGED HYDROGEN ON CRACK GENERATION IN TYPE-304 STAINLESS STEEL. Brush, E. G. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Mar. 1967. Contract AT(04-3)-189. 42p. (EURAEC-1914). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

An evaluation of the role that corrosion-generated H_2 might play in assisting propagation of anodically-generated cladding cracks in nonsensitized Type-304 stainless steel cladding on boiling water reactor fuel is presented. (H.D.R.)

43554 (MLM-1334) PREPARATION AND TESTING OF METAL COATINGS ON URANIUM. Wood, T. W. (Mound Lab., Miamisburg, Ohio). Aug. 30, 1967. Contract AT(33-1)-Gen-53. 10p. Dep. CFSTI.

A limited study of the resistance to aqueous (sea water, distilled water, and water vapor) corrosion afforded U by four coating processes was performed. The corrosion resistance of ion plates of Al was compared with that of Zn hot dip coatings, and of electroplates and carbonyl coats of Ni vacuum annealed at 700°C. The carbonyl coatings, which showed little effect from four days in 96°C condensing steam, were the most corrosion resistant. Zn hot dip did almost as well. The Al ion plates sometimes corroded severely under these conditions. However, ion plating does not require substrate heating, and modifications of the process may improve performance to that of the other coatings. Ion plates of Al were more corrosion resistant than vacuum annealed Ni electroplates. (auth)

43555 (NAA-SR-Memo-11986(Rev.)) EVALUATION OF FERRITIC STEEL IN THE SECONDARY SODIUM SYSTEM. Cummings, R. L. (Atomics International, Canoga Park, Calif.). Oct. 25, 1966. 21p. Dep. CFSTI.

The economic and physical properties of 304 stainless steel, carbon steel, and 2¼ Cr -1 Mo steel (Croloy 2¼) were evaluated for use in the FFTF secondary Na system. It was recommended that schedule 40, 304 stainless steel piping be reduced to schedule 10 at a cost savings of $142,000. It was also recommended that 2¼ Cr -1 Mo tubing with carbon steel fins be substituted for 304 stainless steel in the air-cooled heat dump exchanger at a cost savings of $128,000. It was recommended that carbon steel be used for the purification cold trap at a cost savings of $5,000/trap. Other possible cost reductions were listed for the air dump heat exchanger. (auth)

43556 (NP-17026) THE FORMATION OF BERYLLIUM CARBIDE DURING THE CORROSION OF BERYLLIUM IN CARBON MONOXIDE AND IN CARBON DIOXIDE GAS. Scott, V. D. (Atomic Weapons Research Establishment, Aldermaston (England)). [nd]. 5p. (SRM-Memo-11/59). Dep. CFSTI. UK.

Recent work by Jepson and Antill with radioactive CO and CO_2 has shown that carbon is deposited on Be heated in these gases under static conditions. Two typical specimens (reacted at 700°C) from that work have been examined by optical and electron microscopy, and by electron diffraction. The diffraction pattern shows rings due to the presence of BeO plus three extra rings. Using the oxide rings for calibration, these extra rings were found to have d-spacings of 2.51A, 1.55A and 1.31A, in close agreement with the 2.51A, 1.53A, and 1.31A given by published X-ray work on Be_2C. Microscopical studies showed that the carbide particles are dispersed within the oxide layer. (auth)

43557 REACTIONS OF LIQUID SODIUM AND LIQUID POTASSIUM WITH NIOBIUM PENTOXIDE. Addison, C. C.; Barker, M. G.; Lintonbon, R. M.; Pulham, R. J. (Univ. of Nottingham, Eng.). pp 460-4 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Studies of the liquid alkali metals reactions with the oxides of transition metals include: the reactions of niobium pentoxide with liquid sodium; corrosion of niobium on oxide layer of metal surface with liquid metal coolant; and new compounds of sodium, niobium, and oxygen with high niobium oxidation rates. (D.C.C.)

43558 CORROSION PROPERTIES OF SOME HAFNIUM ALLOYS. Grebennikov, R. V.; Shamashov, F. P. At. Energ. (USSR), 22: 469-73(June 1967). (In Russian).

Binary Hf alloys containing up to 1.0% Fe, Cr, Cu, Mo, Sn, or Ta, or up to 2.5% Nb were arc melted in an Ar atmosphere, vacuum annealed at 800 and 920°C, and then tested for corrosion resistance in water at 350°C at a corresponding steam pressure, and also in steam at 400 to 450°C at a pressure of 220 to 300 atm. Results of the test, conducted for up to 7700 hr, are illustrated. The experimental data indicate that the Hf alloy with 1.0% Cu, in which no substantial increase in the growth rate with increasing temperature was observed. The instability of the corrosion resistance of Hf in steam at 400 to 450°C can be eliminated with alloying. (ATD)

43559 CORROSION OF METALS IN THE MOLTEN LiOH–LiF–H_2O SYSTEM. De Vries, Gerrit (Naval Ordnance Test Station, Pasadena, Calif.); Grantham, LeRoy F. Electrochem. Technol., 5: 335-40(July-Aug. 1967).

A study was made to determine which commercially available alloys would contain molten LiOH(80 mole %)–LiF most satisfactorily under high-pressure steam. Short-term screening tests (3 hr at 800°C) indicated that, in general, the thermodynamic stability of the oxides and fluorides of the materials could be used to predict relative corrosion rates. However, cobalt-based alloys were somewhat more corrosion prone and stainless steels were slightly more corrosion resistant than predicted. Medium-term tests (100 hr at 500 to 800°C) were made to determine the effect of temperature and impurities on corrosion rate. Long-term tests (approx 550 hr at 650°C) under 2500 psi steam were made on Inconel 600 and Nickel 200. The average corrosion rates in these 550-hr tests were approx 10 mils/yr for Nickel 200 and 100 mils/yr for Inconel 600. (auth)

43560 CORROSION OF BERYLLIUM BY SALT WATER. Prochko, R. J. (Wright-Patterson AFB, Ohio); Myers, J. R.; Saxer, R. K. Mater. Protect., 5: 39-42(Dec. 1966).

Investigation of the corrosive effect of chlorides in aqueous environments on pickled and anodized specimens of sheet Be is presented. Experiments in such environments as distilled water, synthetic seawater, natural seawater, 3% NaCl solution, and 3.5% NaCl solution are described. Unprotected Be sheet cannot be used where it will be totally immersed in aqueous chloride environments; it can be used only where pitting attack can be tolerated. The application of stress to both anodized and pickled Be sheet exposed to natural seawater further restricts its use because of stress-corrosion failure. (IAA)

43561 PROPERTIES OF HAFNIUM IODIDE AND Zr–Hf ALLOYS. Evstyukhin, A. I.; Barinov, I. P.; Korobko, I. I. pp 33-43 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Hardness and microhardness of HfI_4 was determined and effects of O_2 and other impurities were studied. The liquidus lines of the Zr–Hf systems prepared by iodide method were found. Oxidation kinetics of Zr–Hf in air and in oxygen at 800°C was studied with iodide alloys and pure metal specimens. (R.V.J.)

43562 EFFECTS OF TEMPERATURE GRADIENT ON THE DISTRIBUTION OF HYDROGEN IN ZIRCONIUM. Emel'yanov, V. S.; Borkov, N. V.; Evstukhin, A. I.; Kazakevich, A. T. pp 12-21 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Tests of temperature gradient according to the height and radius of the cylindrical specimen showed a redistribution of H in Zr from heated to cooled surfaces. A maximum hydration was observed at 245 to 260°C. (R.V.J.)

Preparation and Fabrication

Refer also to abstract 43118.

43563 (GEPP–6) HYDROFORMING MOLYBDENUM SHEET AT ROOM TEMPERATURE. Shepherd, L. W. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). May 15, 1967. Contract AT(29-2)-656. 9p. (R–67ND3). Dep. CFSTI.

An economical and reliable method for deep drawing thin, unalloyed Mo sheet at room temperature is discussed. Using the hydroforming method and other techniques described, thin, unalloyed Mo sheet can be consistently and reliably deep drawn to close tolerances at room temperature. (auth)

43564 (RFP–921) SOLVENTS FOR DEGREASING AND MACHINING PLUTONIUM METAL. Giebel, Ray E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 22, 1967. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Various halogenated solvents were investigated for use in degreasing and machining Pu in glovebox operations. Perchloroethylene was the only solvent investigated which met all the criteria required for the operations. (auth)

43565 (RFP–1007) PREPARATION OF ISOTOPICALLY PURE ^{241}Pu METAL. Conner, W. V. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 8, 1967. Contract AT(29-1)-1106. 8p. Dep. CFSTI.

Procedures are described for the production of two batches of isotopically pure ^{241}Pu metal from PuO_2, and for the recovery of Pu from reduction residues. The conversion of the oxide to PuF_4 was accomplished with F_2. The PuF_4 was reduced to metal using Ca as the reductant, with an I_2 booster. The Pu recovery was performed by HNO_3 dissolution, anion exchange, and oxalate precipitation. (auth)

43566 (SRO–133) A STUDY OF GALLING AND ITS ALLEVIATION IN POWDER METALLURGY COMPACTION. Quarterly Progress Report, June 1–August 31, 1967. Schwartz, E. G.; Clary, R. B. (South Carolina Univ., Columbia. Dept. of Mechanical Engineering). Contract AT(38-1)-475. 18p. Dep. CFSTI.

A literature review is presented on the frictional forces which occur during compression of metal powders. Experimental equipment incorporating punches pressing into a die from both ends to be used in the galling studies is described. Included are 27 references. (H.D.R.)

43567 THE NONELECTROLYTIC DEPOSITION OF TITANIUM ON COLUMBIUM ALLOYS FROM FUSED SALTS. Steinman, J. B.; Warnock, R. V.; Root, C. G.; Stetson, A. R. (International Harvester Co., San Diego, Calif.). J. Electrochem. Soc., 114: 1018-23(Oct. 1967).

A high-temperature cell was designed for deposition of metallic coatings on refractory alloy substrates. The deposition of Ti from fused chloride and fluoride salts onto Nb alloys was investigated at several temperatures from 800 to 1100°C. The as-deposited coatings were generally dense and adherent- and exhibited excellent side-to-side and edge uniformity. An explanation of the driving force and a mechanism for nonelectrolytic deposition is proposed, and an activation energy for deposition is calculated. (auth)

43568 BERYLLIUM TECHNOLOGY. Farthing, T. W. (International Copper Research Association Inc., London); Leech, J. R. Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 16-23 (1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

The technology of Be is outlined. Starting stock for fabrication may be either cast ingot or consolidated powder but the latter is preferred when strength is of primary consideration. Be may be fabricated at temperatures generally between 400 and 1000°C by all the conventional techniques such as rolling, forging, extrusion, and drawing. Physical and mechanical properties are comprehensively listed, attention being drawn to the very high elastic modulus and the high ratio of tensile strength to density. Engineering difficulties in the application of Be arise from its low transverse ductility and impact strength. The toxic nature of the metal is now well recognized and safe working practices are fully established. Examples of current and proposed applications for Be are given, but it is noted that the metal is not yet in widespread use. It is suggested that this is attributable both to its high cost and the difficulty in obtaining adequate isotropic ductility. (auth)

43569 TANTALUM AND ITS ALLOYS AS ENGINEERING MATERIALS. Cooper, M. J.; Mannox, D. J. (Powder Metallurgy Group, Murex Ltd., Rainham, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 24-37(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

The occurrence and extraction, the consolidation and primary working of Ta are briefly summarized as background information. The physical, mechanical, and chemical properties of the pure metal and four alloys are presented in graphical and tabular form. Data are given on secondary fabrication, including several aspects of machining, sheet metal working, and also the methods of cladding available. Details of W-inert gas welding (t.i.g.) and resistance welding are given, with indications of repair work, and of brazing and electron beam welding. Applications are discussed with special emphasis on those in chemical plant manufacture. (auth)

43570 MOLYBDENUM AND TUNGSTEN. Hargrave, D. P. (Murex Ltd., Rainham, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 38-48(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

The potential of Mo and W as high-temperature materials is well known. Their progress towards becoming engineering materials in the widest sense is reviewed. Fabrication procedures are described with reference to the metallurgical characteristics of the two metals. Both the elevated and room temperature mechanical properties of the metals and their commercially available alloys are given and the precautions to be taken in the interpretation of these properties are stressed. The present and possible future applications of W and Mo are given together with the restrictions that exist to their more general usage. (auth)

43571 TITANIUM, BERYLLIUM, AND THE REFRACTORY METALS IN THE AIRCRAFT INDUSTRY. Brown, A. R. G.; Jepson, K. S. (RAE, Farnborough, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 75-89(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

The need for new materials capable of operating at elevated temperatures often while severely stressed is outlined, and the properties of Ti, Be and the refractory metals which give them importance for such application are described. These are "new" metals in that their application as engineering materials is in its infancy and, as yet, generally accepted alloys have not been developed. The difficulties in forming and joining the metals are discussed, and their characteristic properties which make utilization difficult are outlined. Finally, a brief survey is made of the properties obtainable in alloys of the metals described and potential and actual fields of application are discussed. (auth)

43572 REFRACTORY METALS AS POSSIBLE FUTURE AERO-ENGINE MATERIALS. Llewelyn, G. (Bristol-Siddeley Engines Ltd., Bristol, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 90-101(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

Alloys of Nb, Ta, Mo, and W are suitable for components of aircraft engines operating at temperatures beyond the capabilities of Ni- and Co-base alloys. Nb and Ta alloys show promise for fulfilling the need for materials for future turbine blades and hypersonic ram-jet engine components respectively. Coated forged Nb alloys may permit turbine entry temperatures of 1200 to 1300°C or in sheet form they may form parts of the ram-jet engine operating around this temperature range. For temperatures of 1600°C or more for short times, coated Ta alloys, principally in sheet form, appear to be good candidates. Mechanical and physical properties are presented with test results from oxidation and fatigue studies. (auth)

43573 ULTRASONICALLY DISPERSED SODIUM. Pratt, M. W. T.; Helsby, R.; Stanier, H. M. (Imperial Chemical Industries Ltd., Runcorn, Eng.). pp 284-9 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19-22, 1966. See CONF-660712.

Design of a concentrated Na dispersion apparatus for micron size work in hydrocarbon media is presented. An ultrasonic magnetostrictive transducer with a resonant frequency of 25 kcps sealed by a Neoprene ring into a cylindrical Pyrex reactor is used. (D.C.C.)

43574 EXPERIMENTAL TECHNIQUES FOR THE PURIFICATION OF SODIUM. Thorley, A. W.; Raine, A. C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 374-92 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19-22, 1966. See CONF-660712.

Na is purified either by circulation in pumped stainless steel circuits or by three-stage distillation. The former method reduces non-metallic impurities effectively, but corrosion increases metallic impurities, e.g., iron; distillation removes most of the metallic impurities, unless they have similar vapor pressures. Careful control of distillation rates, however, and fractionation of the distillate, improves the removal of such impurities. The processes and the associated technology are described for the different methods of purification. (UK)

43575 SEPARATION OF NIOBIUM AND TANTALUM FROM THEIR MIXED OXIDES BY CHLORINATION IN PRESENCE OF CARBON MONOXIDE. Srinivasan, K. R.; Jena, P. K. (Atomic Energy Establishment, Trombay, India). Trans. Indian Inst. Metals, 19: 180-2(Dec. 1966).

An investigation on the separation of Nb and Ta by chlorination of their mixed oxides (containing about 20% Ta_2O_5) with chlorine in presence of Co has been carried out. The influence of chlorination temperature, Co to chlorine ratio, and their total flow rate, has been studied using each time 5 gs of the mixed oxides and by keeping the amount chlorinated constant between 68 to 71%. Under a suitable experimental condition, Ta_2O_5 in the product has been brought down from 20 to about 2% by a single stage chlorination. Under similar experimental condition, a double stage chlorination of the mixed oxides on 100g scale had been carried out. The chlorides of 1st chlorination have been converted into oxides which on further chlorination have yielded a product containing about 0.5% of Ta_2O_5. (auth)

43576 RECLAMATION OF OFF-GRADE ZIRCALOY MILL SCRAP. PART I. Saratchandran, N.; Sundaram, C. V. (Bhabha Atomic Research Center, Trombay, India). Trans. Indian Inst. Metals, 19: 213-18(Dec. 1966).

The available pyrometallurgical and aqueous processes for recovery of Zr values from off-grade Zircaloy scrap are presented. The problems associated with aqueous processes such as acid dissolution in HF-HNO_3 mixtures, dissolution in ammonium fluoride-ammonium nitrate mixtures (the zirflex process) and electrochemical dissolution; vis-a-vis pyrometallurgical processes such as hydrochlorination (the zircex process), fluidized-bed chlorination, reaction with molten lead chloride and electrorefining, are discussed. The results of small scale studies on the chlorination of Zircaloy scrap are also presented. (auth)

43577 PREPARATION AND STUDY OF SOME PROPERTIES OF Pu MONOCARBIDE. Reshetnikov, F. G.; Artamonov, V. V.; Gurvich, M. G.; Kutaitsev, V. I.; Kuznetsova, V. G.; Bagrova, V. I.; Alekseev, O. A.; Chebotarev, N. T.; Kuzin, N. I. At. Energ. (USSR), 22: 445-50(June 1967). (In Russian).

The results of the investigation of the properties of the production of Pu by the interaction of Pu hydride with C and the manufacture of compact objects from PuC were reported. The effects of Ni introduced into the Pu carbides on the density of the product were investigated and the character of the distribution of Ni in the annealed PuC samples was determined as a function of the C concentration. The thermal expansion coefficient of PuC was measured. Data on the compatibility of PuC with possible construction materials were given. (tr-auth)

43578 POROUS BODIES OF TANTALUM, NIOBIUM, AND ALUMINUM FABRICATED BY METAL SPRAY PROCESSES. Rairden, J. R. (General Electric Co., Schenectady, N. Y.). Electrochem. Technol., 5: 407-8(July-Aug. 1967).

Fabrication of high-surface-area metals by metal-spraying techniques to promote porosity in the deposited bodies was studied. Because of the high melting temperature of Ta and Nb, the plasma-arc spraying process was used for these metals. Porous Al was fabricated by both plasma-arc spraying and conventional flame spraying. Gun-to-substrate distance was very important as the fused-metal droplet cools rapidly after it leaves the plasma. A distance of about 9 in. yielded Ta deposits that were highly porous, yet strong enough to be handled and sheared without difficulty. Only a few experiments were performed with Nb, but results were comparable to Ta. Porous Al, fabricated in an air atmosphere by conventional flame spraying with a gun-to-substrate distance of about 12 to 14 in., yielded a strong, somewhat ductile, free-standing body with a capacitance value over six times as great as would be expected for a similarly anodized nonporous Al foil of the same dimensions. (P.C.S.)

43579 PREPARATION AND SOME PROPERTIES OF AMERICIUM METAL. Wade, W. Z.; Wolf, T. (Univ. of California, Livermore). J. Inorg. Nucl. Chem., 29: 2577-87(Oct. 1967).

The reduction, distillation, and casting of ^{241}Am metal are described. Some physical property determinations are also reported. Approximately 200 g of AmO_2 were reacted with La in fifteen separate batches. Yield efficiency, reproducibily attainable, was demonstrated to be in excess of 80%. The reproducible purity achieved was better than 99.9% (based on 100% minus all spectrographically determined impurities). Physical properties determined were: immersion density = 13.671 g/cm^3, transformation temperature = 1079°C, latent heat of transformation = 1.40 kcal/mole, fusion temperature = 1176°C, and latent heat of fusion = 3.44 kcal/mole. (UK)

Properties Evaluations

Refer also to abstracts 43946, 43965, 43983, 44148, 44151, 44815, and 44882.

43580 (AGN-8232) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, April 1-June 30, 1967. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Aug. 1967. Contract AT(04-3)-368. 35p. Dep. CFSTI.

Electron microscope examination of low-cobalt Hastelloy X specimens aged for 10,000 hours at 1450°F in air revealed a different precipitate particle morphology than that observed in specimens exposed at 1300°F. The particles in the 1450°F specimens are plate-like and the particles in the 1300°F specimens are rod-shaped. The effect of σ phase on the mechanical properties of Hastelloy X tubing aged in air for up to 12,500 hours was investigated. Oxidation weight change data for sheet specimens from three heats of Hastelloy X aged in air at 1900 and 2000°F were compared. Continuous weight change testing of specimens of four heats of Hastelloy X in air at 1900°F was continued, and comparisons between the creep rate at 1800°F of five heats revealed wide heat-to-heat variations. Comparisons between uniaxial tensile and centrifugal creep data obtained at 1800°F show good correlation. (H.D.R.)

43581 (CEA-R-3150) CONTRIBUTION A L'ETUDE DE LA DIFFUSIVITE THERMIQUE DES SOLIDES. (Contribution to the Study of Thermal Diffusivity of Solids). Zankel, Karl (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1967. 52p. (In French). Dep.

Thesis. Submitted to Univ., Grenoble, France.

Angström's method has been reviewed for its application to measurements of thermal diffusivity and conductivity on short specimens. An apparatus and a technique have been developed for rapid and precise measurements of a large variety of materials, which might also contain heat sources. This technique allows measurements at both high and low temperatures. Stainless steel, Ni and UC specimens were tested and the results of the thermal diffusivity measurements between 50 and 700°C are presented. (auth)

43582 (COO-1198-479) COLOR CHANGES IN THE COMPOUND $AuAl_2$ INDUCED BY IMPERFECTIONS. Shih, Han C. (Illinois Univ., Urbana). Aug. 1967. Contract AT(11-1)-1198. 45p. Dep. CFSTI.

Distinct color changes when cold-worked samples of $AuAl_2$ are annealed were established. They were demonstrated as shifts of the spectral absorption edge which moves toward shorter wavelengths during the annealing of a heavily deformed crystal. The amount of the shift depends on the annealing temperature and time. Similar results were obtained for powdered specimens and evaporated thin-films. No such effect was observed for the pure component metals. Two modes of investigation were used for high temperature reflectivity studies of $AuAl_2$. That is, isothermal measurements were made, as well as changes as a function of constantly increasing temperature. As the temperature rose the absorption spectrum gradually flattened. (P.C.H.)

43583 (EUR-34791) STUDIO DI LEGHE TERNARIE DI URANIO-MOLIBDENO-NIOBIO E URANIO-MOLIBDENO-ZIRCONIO A BASSO TENORE DI LEGANTE. Relazione Finale. (Study on Ternary Alloys of Uranium-Molybdenum-Niobium and Uranium-Molybdenum-Zirconium with Low Alloying Content. Final Report). Fizzotti, C.; Masperoni, A. (Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari). Apr. 24, 1967. Contract 001-62-6 TEGI. 70p. (In Italian). Dep.

Consideration is given to various elements, such as Mo, Nb, Zr, Al, Si, Fe, and C, which, when added in small quantities to U should improve its behavior under neutron irradiation. Special attention is paid to the ternary alloys of U-Mo-Nb and U-Mo-Zr. Descriptions are given of the tests that were carried out to ascertain the characteristics of these alloys: heat treatments (continuous cooling, quenching, and annealing, interrupted cooling, interrupted quenching); thermal-stability tests (aging and thermal cycling); mechanical and corrosion tests. Some characteristic isotherms of the U-Mo-Nb system are discussed. The criteria adopted for the choice of some of these alloys and of the relevant heat treatments, with a view to carrying out irradiation tests on them, are presented. (auth)

43584 (GEMP-543) HIGH TEMPERATURE CREEP-RUPTURE BEHAVIOR OF UNALLOYED TUNGSTEN. Flagella, P. N. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Aug. 31, 1967. Contract AT(40-1)-2847. 24p. (CONF-670935-2). Dep. CFSTI.

From 3rd International Symposium, High Temperature Technology, Pacific Grove, Calif.

Unalloyed wrought arc-cast tungsten sheet exhibits a shorter rupture life, is less creep resistant, and is considerably more ductile than unalloyed wrought powder-metallurgy W sheet for the temperature range of 1600 to 3000°C. Considerable variation in the creep-rupture behavior was observed in the wrought-powder-metallurgy W from various vendors. This observation is the same as that made in a previous investigation for Mo. In a comparison of the rupture data for arc-cast W and arc-cast Mo on a homologous temperature isochronal plot, consistent behavior is shown. The data for the two materials are coincident on a log-stress versus homologous-temperature plot. Steady-state creep data for the arc-cast W show a good correlation when corrections for elastic modulus and diffusion coefficient are applied. Analysis of the transient creep process of arc-cast W was made using various first-stage creep equations. Experimental data were best described using a polynomial in $t^{\frac{1}{3}}$, the de Lacombe equation, and a hyperbolic sine creep equation. Several other equation forms, including the Anbrade and Cottrell-Aytekin equations, are also fairly accurate. (auth)

43585 (IITRI-B6072-4) VANADIUM ALLOY STUDIES. Bi-monthly Report No. 4, May 11-July 10, 1967. (IIT Research Inst., Chicago, Ill.). Aug. 7, 1967. Contract N00019-67-C-0122. 10p. CFSTI.

V alloys containing 20 or 25% each of Nb and Ta, along with small Ti, Si, and C additions, were evaluated for fabricability and aging response. Ti up to 3% produced rapid aging and overaging of the V-20Nb-25Ta base at 1300°F. Alloys based on V-20Nb-20Ta or V-25Nb-20Ta were more fabricable than the higher-Ta compositions; some of the improvement may be attributed to warm rolling. (auth)

43586 (JAERI-1137) ITINERANT ANTIFERROMAGNETISM IN CHROMIUM ALLOYS. Komura, S. (Japan Atomic Energy Research Inst., Tokyo). May 1967. 36p. Dep.

Thesis. Submitted to Univ. of Tokyo, Japan.

The electrical resistivity and the powder neutron diffraction patterns for Cr-V, Cr-Mn and Cr-Mo binary alloys as well as Cr-V-Mn ternary alloys have been measured at various temperatures. From these measurements the type of magnetic structure and corresponding physical quantities such as Néel temperature, magnetic moment and wave vector of spin density wave (SDW) state were determined. The results are compared with each other on the same scale of effective concentration, i.e., Mn concentration subtracted by V concentration in units of atomic percent. The overall results, expressed as a unique function of effective concentration, show a good agreement between Cr-V, Cr-Mn binary alloys and Cr-V-Mn ternary alloys. The main conclusion deduced from the experimental results is a positive, though not decisive, support for the validity of rigid band approximation. The results are further discussed in terms of the three kinds of SDW model for Cr; free electron model, single-band model and two-band model. The bearing of the Fermi surface in its relation with Brillouin zone boundaries is analyzed on the basis of extended HUME-ROTHERY'S rule. Following this analysis a possible explanation for incommensurable-to-commensurable transition in Cr-Mn and Cr-V-Mn alloys as a function of electron concentration is proposed. (auth)

43587 (N-67-25822) DETERMINATION OF THE SOLUBILITY OF POTASSIUM AND CESIUM IN LITHIUM. Tepper, F.; Udavcak, R.; Zelenak, J. (MSA Research Corp., Callery, Pa.). Apr. 16, 1964. 9p. (NASA-CR-83870; MSAR-64-19). CFSTI.

An advanced propulsion system based upon liquid MHD power conversion has been conceived at the Jet Propulsion Laboratory. The liquid consists of a solution of a heavier alkali metal such as Cs in liquid Li. Knowledge of the solubility limit of the heavier alkali metal in Li, over working temperatures of the system, is necessary for conceptional design. Two approaches have been utilized in the investigation. The first involves decantation at test temperature of a saturated Li solution from the more dense liquid solute. This experimental technique was essentially that employed in determination of Cs in Li to 1800°F. The second approach involved measurement of equilibrium vapor pressure of mixture of the solute with Li for different molar ratios. (auth) (STAR)

43588 (SC-CR-67-2611) THE COMBUSTION OF METALS, Final Report, July 1, 1964-June 30, 1966. Hansel, James G.; Mellor, Arthur M.; Sullivan, Harry F. (Princeton Univ., N. J.). May 1967. Contract AT(30-1)-3451. 60p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The details of the interactions between metals and oxidizers which occur at elevated temperatures are described. A fundamental distinction between oxidation and self-sustained combustion permits detailed classification of the observed phenomena and lends insight into the appropriate ignition reactions as well. Earlier studies at Princeton revealed that certain fundamental criteria generally divided metals into two categories: those that burned by condensed phase reactions and those that reacted largely in the vapor phase. The condensed phase combustion of Mo and Ta was studied experimentally and the results compared with thermodynamic predictions as well as with the results of other investigators. Experiments with Ca have indicated that the generally accepted model of the structure of vapor phase metal diffusion flames may not be correct. This experimental finding allows other combustion models to be formulated which include heterogeneous reactions on condensed oxide particles and chemiluminescent radiation. (auth)

43589 (TID-24045) STRESS-RUPTURE AND CREEP BEHAVIOR OF HAYNES ALLOY NO. 25 AT 1400^{0}, 1700^{0}, AND 2000^{0}F IN AIR. Flagella, P. N.; McCullough, W. L. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Aug. 18, 1967. Contract AT(30-1)-3535. 26p. (GE-NMP-67-528). Dep. CFSTI.

The stress-rupture and creep characteristics of Haynes Alloy No. 25 were determined for samples in the as-fabricated condition. Specimens containing circumferential butt-weld joints and the effect of a coating on both welded and unwelded samples were also evaluated. (H.D.R.)

43590 (TRG-Report-1510) CALIBRATION DRIFT EFFECTS IN NICKEL-ALLOY THERMOCOUPLES. Evans, R. A.; Holt, J. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). 1967. 35p. Dep. CFSTI. UK 5s. 6d.

Calibration drift tests were carried out on Ni-alloy thermocouples at temperatures from 200 to 650°C, with temperature profiles typical of AGR and Magnox reactors. The experiments showed that calibration drift does not take place below 280°C, but can reach +1 to +4°C in 100 days at 400°C. It is deduced that this drift takes place in the positive (Chromel) leg of the thermocouple. It is shown that drifts at 400°C can be prevented by heat treatment of the whole cable before putting into service. (auth)

43591 (UCID-15205) OUTGASSING OF COMMERCIAL TUNGSTEN SHEET IN VACUUM. Space Power Note No. 232. McElroy, James (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 14, 1967. Contract W-7405-eng-48. 4p. Dep. CFSTI.

A test was performed to determine outgassing of commercially available W radiation shield material. The results indicate initial rates are 2.5 orders of magnitude greater than accepted LRL standards for vacuum systems. Considerable effort must be expended in cleaning and outgassing of such materials for use in high vacuum systems. (auth)

43592 (UCRL-70341) THE EFFECT OF BIAXIAL STRESS ON THE CREEP PROPERTIES OF POLYMETHYL METHACRYLATE. Zaslawsky, Maurice (California Univ., Livermore. Lawrence Radiation Lab.). May 26, 1967. Contract W-7405-eng-48. 35p. (CONF-671001-1). Dep. CFSTI.

From Society of Experimental Stress Analysis, Chicago, Ill.

Biaxial creep tests have been performed on thin-walled tubes of polymethyl methacrylate at 116°F and 50% R. H. The tests were carried out under radial loading to a specified stress state, and maintaining that stress state for a finite time. Additional tests involved a constant stress state for a period Δt_1, and then the specimen was rapidly subjected to a second stress state which was maintained for a period Δt_2. The experimental apparatus and procedure are described. The results for the range of stress, temperature, and time investigated shows that the creep behavior can be described by the form $\epsilon = \epsilon_0 + mt^n$ where ϵ is the strein, ϵ_0 is the time-independent portion of the strain, and m and n constants; and that n appears to be independent of stress state in the 4th quadrant ($-\sigma_z$ axial stress, $+\sigma_\theta$ tangential stress) and m a linear function (log log) of effective stress. In the first quadrant ($+\sigma_z$, $+\sigma_\theta$), the values of m and n are dependent on stress state, the constant m being also dependent on effective stress. As two measurements are made for ϵ_θ, tangential strain, a description of the deformation is given. Some results of pre-strain history and fracture are also presented. (auth)

43593 SYSTEMS OF ALKALI AND ALKALINE EARTH METALS. Klemm, W.; Kunze, D. (Univ., Muenster, Ger.). pp 3-22 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Experimental procedures and fabrication of alkali and alkaline-earths products for testing are presented. Quantity, analytical composition, melting point, and x-ray diagrams of the products with beryllium are also presented. (D.C.C.)

43594 MULTICOMPONENT ALKALI METAL ALLOYS. Tepper, F.; King, J.; Greer, J. (Mine Safety Appliances Research Corp., Evans City, Pa.). pp 23-31 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Experiments were carried out to characterize three-(or more) component systems. The first consideration was to determine the minimum melting point of the Na-K-Rb, Na-K-Cs, Na-Rb-Cs and K-Rb-Cs systems. The low-melting portions of the Na-K-Cs phase diagram were then studied, since this system appeared to have a eutectic melting below −100°F. Vapour pressure, liquid density, compressibility and liquid viscosity for the ternary Na-K-Cs eutectic were measured, and techniques of measurements are described. (UK)

43595 HIGH-TEMPERATURE PROPERTIES OF ALKALI METAL VAPORS. Ewing, C. T.; Stone, J. P.; Spann, J. R.; Miller, R. R. (Naval Research Lab., Washington, D. C.). pp 75-81 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Properties of Cs, K, and Na liquid alkali metals are presented for 1400°C and 300 to 500 psi. The apparatus for measuring the compressibility of these vapors at 1400°C and 300 to 500 psi is described. (D.C.C.)

43596 LATENT HEAT OF VAPORIZATION OF POTASSIUM: ITS EXPERIMENTAL DETERMINATION. Achener, P. Y. (Aerojet-General Nucleonics, San Ramon, Calif.). pp 82-91 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The latent heat of vaporization of K was measured from 543° to 1041°C in a flow-calorimeter-type apparatus composed of a boiler with internal heater and guard heater, a condenser, and a volumeter. The boiling temperature was established by means of an Ar overpressure. A technique of double measurements was developed which permitted the elimination analytically of heat losses between boiler and guard heater. The following equation was fitted to the latent heat data: $h_{fg} = 9.063 \times 10^4 - 17.09\ T$ where h_{fg} is in absolute joules/g.-mole and T is in degrees K. (auth) (UK)

43597 INTERMETALLIC COMPOUNDS AND ALLOYS OF THE ALKALI METALS. Mott, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). pp 92-113 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The alloying characteristics of the alkali metals are reviewed in the light of rules originally put forward by Hume-Rothery and his collaborators and subsequently modified by other workers. The nature of the alloy systems between the alkali metals and the various sub-groups of the Periodic Table is largely governed by the large increase in atomic size in proceeding from Li to Cs and the changes in the electronegativity difference for a given sequence of alloys. Thus both solid and liquid solubilities become more restricted with increasing atomic number of the alkali metal, while the number of compounds often decreases. Compound formation also generally increases with increasing atomic number of the alloying element within a given sub-group, with the majority of the intermetallic compounds formed with the B sub-group elements. The highest melting-point compounds in alloys with Groups IIB and IIIB elements are those whose structure and stability are dominated by size factor considerations, whereas in alloys with Group VB and VIB elements the most stable phases are those controlled by normal valency requirements. The transition between these criteria appears to occur in alloys with the Group IV elements. (auth) (UK)

43598 WETTING OF SOLID METALS BY LIQUID ALKALI METALS. Jordan, D. O.; Lane, J. E. (Univ. of Adelaide). pp 147-52 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Twelve systems were studied: Cu−Li, Hg−Na, Ag−Na, Au−Na, Na−Pt, Na−Pd, Na−Zn, Cu−Na, Na−Ni, Ag−K, K−Zn, Cu−K. Contact angles were measured with a vertical plate balance. Cu−Li, which formed a solid solution, and Na−Zn, Ag−Na, Au−Na, Hg−Na and K−Zn, which formed intermetallic compounds, all showed wetting behavior, advancing angles of zero being recorded. Na−Pd, Na−Pt and Ag−K showed immediate advancing and recording contact angles of zero, and Cu−Na, Na−Ni and Cu−K showed non-zero contact angles over the temperature range studied. (UK)

43599 THE WETTING BEHAVIOUR OF SOME ALLOYS BASED ON IRON, NICKEL, AND CHROMIUM IN LIQUID SODIUM. Longson, B.; Thorley, A. W. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 153-66 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

A description is given of the construction of a Na rig and magnetic balance used to determine the wetting behavior of several Fe, Ni and Cr based alloys at various temperatures and O_2 levels. Because of scatter in published values, the density and surface tension of liquid Na were determined preliminary to the wetting studies. The following equations were derived: Density: $\rho = 0.952 - 2.45 \times 10^{-4}T$ (T = °C) Surface Tension: $\gamma = 203 - 0.08$ (T-98) (for relatively pure sodium), $\gamma = 203 - 0.11$ (T-98) (for oxygen-saturated sodium). The wetting studies showed that Ni wetted quite rapidly in pure Na (less than 1 hour), that the wetting temperature for Ni and Fe decreases, with increase in oxygen level, and that the alloys do not wet as readily as pure metals in O_2 saturated Na, but the rate increased with the nickel content of the alloy. (UK)

43600 INFLUENCE OF THE WATER CONTENT IN OXYGEN ON THE KINETICS OF OXIDATION OF SODIUM AND POTASSIUM. Hatterer, A.; Thevenin, M. (Ecole Superieure de Chimie, Mulhouse, France). pp 167-82 of The Alkali Metals. London, The Chemical Society, 1967. (In French).

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

A review is given of existing work on the oxidation of alkali metals, the mechanisms involved, and the methods of investigation employed. Two different methods are described which were employed to study the influence of the water content in O_2 on oxidation-differential manometry and thermogravimetry. Two versions of the latter method were used with and without circulation of the gas. Results are incomplete, but it is clear that water in the gas plays an important part in oxidation, both in initiation and development, although the effect of other factors, such as sorption on the apparatus and the alkali metal, diffusion in the gas and at the interface, must be taken into consideration. (UK)

43601 ^{7}Li NUCLEAR MAGNETIC RESONANCE STUDIES OF THE SOLVATION OF LITHIUM IONS. Akitt, J. W.; Downs, A. J. (Univ. of Newcastle upon Tyne, Eng.). pp 199-206 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966 See CONF-660712.

A survey of ^{7}Li NMR spectra for Li compounds in solution to assess the usefulness of this technique for investigating the solvation of the Li^+ cation both under aqueous and non-aqueous conditions is presented. (D.C.C.)

43602 APPLICATION OF SODIUM CHEMISTRY IN FAST REACTORS. Tyzack, C. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). pp 236-59 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The chemistry of Na and its impurities, and its chemical and metallurgical interactions with circuit and core materials, are reviewed. After discussing the methods of monitoring and controlling the impurity levels in the Na, work on the effects on constructional materials through solution, corrosion, erosion, and mass transfer processes is discussed. Finally, the mass transfer of iron and steel in Na, as the only practicable containment materials, and particularly the role of oxygen in the process are considered. (UK)

43603 REACTION OF CARBON MONOXIDE WITH SODIUM. Sinclair, V. M.; Davies, R. A.; Drummond, J. L. (United Kingdom Atomic Energy Authority, Thurso, Scotland). pp 260–9 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The direct reaction between carbon monoxide and liquid sodium was studied at pressures up to one atmosphere and at temperatures between 200°C and 500°C. The reaction appears to proceed in three stages; firstly, a small but rapid reaction, followed by a slow reaction phase which would appear to be an induction period, and finally a rapid exothermic reaction which is the start of the main reaction with the bulk of the sodium. X-ray analysis confirmed the presence of sodium rhodizonate in the initial reaction products, but its concentration decreased as new products were formed. The C/Na ratio of the total reaction product decreased to a final value of about 0.9 as the reaction proceeded. Heating the products to high temperatures released carbon monoxide as the only gas; the decomposition pressure of the gas was measured. Hydrolysis of the reaction products helped to identify some of the compounds present, including carbonate and acetylide compounds. (UK)

43604 REACTION BETWEEN ALKALI METALS AND WATER. Shaede, E. A.; Walker, D. C. (Univ. of British Columbia, Vancouver). pp 277–83 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The dissolution of Na in water was investigated to determine whether, by analogy of the behavior in a number of non-aqueous polar solvents, the reaction proceeded according to the equation $M + H_2O \rightarrow M^+_{aq} + e^-_{aq}$ and whether e^-_{aq} is then the precursor of H_2, rather than a H-atom. Examination of the possible occurrence of e^-_{aq} was made by chemical kinetic studies, that is by investigation of the gaseous products and reaction rates occurring when dilute Na amalgam reacted with deaerated water containing appropriate amounts of nitrous oxide and methyl alchol as scavengers. The most positive conclusion was that H-atoms are not produced when Na amalgam reacts with neutral or alkaline waters. There were strong indications that the reactive species are hydrated electrons the reaction being $Na + aq \rightarrow Na^+_{aq} + e^-_{aq}$. (UK)

43605 METHODS FOR THE ANALYSIS OF OXYGEN, HYDROGEN, AND CARBON IN SODIUM. Walker, J. A. J. (United Kingdom Atomic Energy Authority, Culcheth, Eng.); France, E. D.; Drummond, J. L.; Smith, A. W. pp 393–400 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The available physical and chemical techniques for separating Na from the particular impurity to be determined are compared. The methods are discussed with particular reference to those developed by the U.K.A.E.A. Versatility, sensitivity, sample size, blanks, interferences, and general chemistry are considered. Experience in the U.K.A.E.A. suggests that the diffusion method for H_2, and the distillation methods for O_2 and C_2, are suitable for routine use for Na from high-temperature circulating loops. (UK)

43606 DETERMINATION OF THE SOLUBILITY OF OXYGEN IN SODIUM USING THE VACUUM DISTILLATION ANALYTICAL TECHNIQUE. Rutkauskas, V. J. (Los Alamos Scientific Lab., N. Mex.). pp 401–2 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The solubility of O_2 in the range of 125 to 325°C is evaluated by a method involving a dynamic Na system constructed of type 304 stainless steel, containing 8 gallons of Na, a forced circulation precipitation chamber, and a vacuum distillation sampling system for the physical removal and analysis of Na samples. (auth)

43607 A TECHNIQUE FOR CALIBRATION OF ELECTROCHEMICAL OXYGEN METERS IN POTASSIUM. Minushkin, Bertram; Goldmann, Kurt (United Nuclear Corp., Elmsford, N. Y.). pp 403–15 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The technique described consists in adding known amounts of O_2 to gettered K and relating the observed changes of meter voltage to the known changes in O_2 concentration. A description is given of the equipment used, and of the results which were obtained for the calibration of eleven sensors. (UK)

43608 SOLID-STATE STUDIES OF ALKALI METALS IN TRANSITION METAL OXIDES. Sienko, M. J. (Cornell Univ., Ithaca, N. Y.). pp 429–51 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

The electric, magnetic, and magnetic resonance properties of filled-band transition-metal oxides can be altered by introduction of oxygen vacancies or by interstitial insertion of alkali atoms. Conventional solid state studies on alkali atoms, such as conductivity, Hall voltage, and Seeback effect, have disclosed carrier densities and carrier mobilities, but the role as an electron-donor center and as a band generator is still unknown. In the metallic systems, the specific identity of the cation has little influence on the carrier properties, but in the semi-conductive materials the nature of the cation seems to play a considerable role in fixing the ionization energy of the donor center and hence in determining the carrier density. Except for Li^+, where spin-lattice relaxation analysis suggests large ionic mobility, the motion of the alkali cations in transition-metal oxides is negligibly small at all but high temperatures. At ultra-low temperatures (less than 20°K) some of the alkali-doped transition-metal oxides become superconducting, indicating cooperative exchange coupling of the alkali valence electrons. (auth)

43609 TENSILE STRENGTH OF SOME METAL MELTS IN WIDE RANGE OF TEMPERATURES. Lazarev, V. B. (Inst. of General and Inorganic Chemistry, Moscow). Teor. Eksp. Khim., 3: 504–7(July–Aug. 1967). (In Russian).

Measurements of the tensile strength of Sn, In, and Ge in the temperature range from melting point to 1700°C, and Pb, Tl, Bi, and Cd at 1400, 1100, 1300, and 600°C, respectively, showed their tensile strength to be a linear function of the temperature. Qualitative evaluation was made of the critical temperature of Cd and Ge. Data obtained were used in determining the structure of the melted metals. (tr-auth)

43610 VERSATILE ALUMINUM ALLOY FOR CRYOGENIC APPLICATIONS. Develay, R. (Centre de Recherches Metallurgiques de Pechiney, Chambery, France); Faure, A.; Lehongre, S.; Mugnier, D.; Schroeter, D. pp 484–95 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Tests were made on the aluminum alloy AZ5G at 77° and 20°K to determine its strength properties, fracture toughness, weldability, and physical properties. (M.O.W.)

43611 EFFECT OF NUCLEAR RADIATION ON THE PHASE COMPOSITION OF URANIUM ALLOYS WITH LOW CONTENT OF ALLOYING ELEMENTS. Konobeevskii, S. T.; Sokurskii, Yu. N.; Bobkov, Yu. V.; Dubrovin, K. P.; Protsenko, L. N. At. Energ. (USSR), 22: 450–9(June 1967). (In Russian).

Specimens of binary U alloys containing 0.21 at. % Fe, 0.88 at. % Al, or 0.68 at. % Si were annealed in vacuum at 850°C for 2 hr and oil quenched. Some of the specimens were annealed at temperatures in the α-region. All the specimens were subjected to the radiation of an integral flux of thermal neutrons at $1.1 \cdot 10^{17}$ to $2.3 \cdot 10^{19}$ n/cm^2 with a flux density of $5 \cdot 10^{12}$ to $1 \cdot 10^{14}$ n/cm$^2 \cdot$ sec. The temperature of specimens during radiation was 60 to 80°C. Specimens subjected to radiation of $4.2 \cdot 10^{17}$ n/cm^2 were afterwards isochronously annealed at 100 to 500°C at intervals of 25°C and for 25 min at each interval. Changes in phase composition were determined by the electric resistivity method. It was found that the electric resistivity of binary uranium-alloy specimens, fully annealed after radiation at 350°C, increased proportionally to the content of alloying elements. The coefficient of proportionality for uranium alloys containing Fe, Al, or Si was 18, 20, and 17 microohm-cm, respectively, per 1 at. % of the alloying element. The increase in electric resistivity is caused by radiation-induced diffusion of finely dispersed particles of intermetallic compounds and by the formation of zones, enriched with alloying elements, around these particles. In specimens annealed to obtain γ-phase, a partial decomposition of metastable solid solutions took place under the effect of radiation. Isochronous annealing of the specimens radiated with $4.2 \cdot 10^{17}$ n/cm^2 restored their original electric

resistivity, apparently because of the restoration of the initial intermetallic compound particles. (ATD)

43612 STUDIES OF MAGNETIC HARDNESS IN VICALLOY USING THE MOESSBAUER EFFECT. Gorodetsky, G.; Shtrikman, S. (Weizmann Inst. of Science, Rehovoth, Israel). J. Appl. Phys., 38: 3981-2(Sept. 1967).

Moessbauer spectra were taken at room temperature on rolled Vicalloy samples in (i) a state obtained by quenching the sample from 950°C; (ii) a state obtained by annealing for optimum permanent magnet properties. Annealing results in a narrowing of the absorption peaks, an increase in hyperfine field, and the appearance of an additional absorption peak indicative of a paramagnetic phase. These results are interpreted in terms of the known phase diagram of Fe–Co–V, and lend support to the description of Vicalloy magnets as fine-particle magnets. (auth)

43613 THE THERMAL RADIATION OF TUNGSTEN ALLOYS AT TEMPERATURES UP TO 3000°K. Thomas, Ludwig K. (Westinghouse Electric Corp., Pittsburgh). pp 266-71 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

The normal spectral emissivity and the angular dependence of thermal radiation of W–Ta, W–Mo, and W–Re has been measured in the temperature range 2000 to 3000°K and in the wavelength region 0.25 to 6μ. The optical constants of Ta–W alloys have been calculated from experimental data. The results are interpreted in terms of electron transitions between filled bands and states close to the Fermi surface. (auth)

43614 NEW ENGINEERING MATERIALS. A Conference Arranged by the Process Engineering Group, 13th and 14th October 1965, Birmingham, England. Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 1-224(1965-66). (CONF-651089).

Topics discussed include: beryllium, molybdenum, niobium, tantalum, titanium, tungsten, and zirconium technology as engineering materials; the development of zirconium alloy pressure tubes for the Winfrith Heath steam generating heavy water reactor; sodium and its alloys with potassium; refractory metals as possible future aero-engine materials; pure silicon; properites and applications of the platinum metals and rhenium; copper and its alloys; advanced nickel-chromium base alloys; carbon; developments in engineering ceramics; ceramic-metal composites; and developments in refractory castables. Separate abstracts are prepared for ten of the seventeen papers presented. (D.C.C.)

For abstracts of individual papers see: 43568, 43569, 43570–43572, 43615–43617, 43659, and 44865.

43615 TITANIUM, ZIRCONIUM, AND NIOBIUM. Green, T. E.; Minton, C. D. T. (Imperial Metal Industries (Kynoch) Ltd., Birmingham, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 4-15(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

Physical and mechanical properties of Ti and Zr are compared with conventional structural metals and their availability and applications are discussed, together with fabrication techniques and current material development. The second part deals with Nb and its alloys, their uses at elevated temperature, in nuclear and other applications; and their superconducting properties. Physical and fabrication properties are given and operational experience described. (auth)

43616 SOME PROPERTIES AND APPLICATIONS OF THE PLATINIUM METALS AND RHENIUM. Darling, A. S. (Johnson, Matthey and Co. Ltd., Wembley, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 104-18(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

The ability of Pt and certain of its alloys to function effectively as structural materials for long periods in air at temperatures above 1400°C ensures for these materials a remarkable position in a variety of industrial processes. The physical characteristics of the Pt metal group are reviewed in this paper and contrasted with those of the base metal Re which is similarly rare and expensive. Re and the refractory Pt metals oxidize rapidly when heated in air and Rh–Pt alloys are generally employed when prolonged resistance to high temperature creep is required. Dispersion strengthened Pt alloys provide even higher elevated temperature properties. Economic justification for the industrial use of the Pt metal group is not difficult to provide because most processes center on the unique ability of these elements to perform a specific function. In other instances their employment results in a cheaper and superior product. The applications of Pt in the glass industry are briefly described and an outline presented of the philosophy underlying the development of some new Re and Pt alloys. Consideration is given to the characteristics of H–Pd alloys and to their fuel cell and energy storage applications. (auth)

43617 RECENT DEVELOPMENTS IN ENGINEERING CERAMICS. Popper, P. (British Ceramic Research Association, Stoke-on-Trent, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 181-92(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

Ceramics of inorganic non-metallic materials which are shaped when in a finely divided form, followed by a high-temperature sintering treatment are discussed. A better understanding of the properties of ceramics (e.g., Al_2O_3) can be gained by the study of the properties of the material in single crystal form (e.g., sapphire). The properties of different materials can be related to their crystal structure. This scientific pursuit has led to a number of new materials, Si_3N_4, and BN. Compared with metals ceramics complete favourably on account of their high strength at high temperatures, good wear and corrosion resistance. Their main drawbacks are brittleness and failure by thermal stresses. The application of new methods of fabrication has been aimed at producing ceramics of high density and to accurate dimensions. The properties of the following materials will be discussed in some detail: Al_2O_3, Si_3N_4, SiC, and BN. It will be demonstrated that different methods of fabrication can result in widely differing properties of the same material. Small grain size and high density are essential for good mechanical strength. Methods of joining ceramics to metal will be discussed. Some important applications will be reported and consideration will be given to problems facing the designers. (auth)

Structure and Phase Studies

43618 (BNL–11717) DEFECT STUDIES IN METALS. Attardo, M. J.; Davidson, J. L.; Galligan, J. M.; Jeannotte, D. (Brookhaven National Lab., Upton, N. Y.). [1967]. 20p. (CONF-670909–7). Dep. CFSTI.

From International Conference on the Strength of Metals and Alloys, Tokyo, Japan.

Some measurements of defects present in crystals as a result of irradiation or quenching are presented. It is shown that interstitial atoms are removed from Pt in stage III recovery. The presence of depleted zones is shown to be a controlling factor in the change in yield stress in irradiated Pt. In irradiated W the energy of motion of single vacancies has been measured. The process takes place with an activation energy of 3.3 eV. This result precludes extensive motion of vacancies in W in stage III recovery. Some studies of quench hardening in Cu show that the hardening occurs in two stages if the quenching is performed under clean conditions. The second stage is associated with the growth of Frank dislocation loops and an experimental value of the rate limiting process for plastic deformation is about 4.5 eV. (auth)

43619 (COO–588-13) TRANSFORMATION CHARACTERISTICS OF ZIRCONIUM–NIOBIUM ALLOYS. Interim Technical Report No. 10. Yaffe, P. E.; Perkins, A. J.; Jackson, W. A.; Hehemann, R. F. (Case Inst. of Tech., Cleveland, Ohio. Dept. of Metallurgy). July 31, 1967. Contract AT(11-1)-588. 13p. Dep. CFSTI.

Transmission electron microscopy has been employed to study the omega transformation in Zr–Nb alloys. The studies confirm and strengthen considerably earlier concepts of the nature of omega deduced from X-ray diffraction studies. Specifically, omega nucleates homogeneously in the parent phase and develops as a modulated structure consisting of a periodic arrangement of beta and the four orientations of omega. Omega regions are about 150-200 Å in diameter in quenched alloys and increase in size with aging but remain less than 1000 Å in diameter. The concept that diffuse streaking in electron and X-ray diffraction patterns results from a modulation in atomic positions rather than from small particle size effects is reaffirmed. The distinction between the athermal formation of omega and classical martensite reactions is considered in terms of the phenomenological theory of these reactions and it is concluded that omega formation is characterized simply by the shuffles required to reposition atoms within the unit cell. Similar phenomena may be expected in other systems and work has been initiated on the Ti–Ni intermetallic compound to explore this possibility. (auth)

43620 (COO–1198-469) STUDIES OF THE MARTENSITIC PHASE TRANSITION IN TANTALUM–RUTHENIUM ALLOYS. Schmerling, Michael Allen (Illinois Univ., Urbana). Aug. 1967. Contract AT(11-1)-1198. 56p. Dep. CFSTI.

Electrical resistance measurements, metallographic observa-

tions, and magnetic susceptibility measurements were made to verify the existence of a martensitic phase transformation in near-equiatomic Ta–Ru alloys with Ta compositions from 45 to 55 at. %. X-ray powder patterns of the room temperature structure indicate that for the alloys closest to 50% the transformation goes from an initial phase with a CsCl-type structure to a face-centered tetragonal structure and then to a face-centered orthorhombic structure with decreasing temperature. Patterns indicate for the 45 and 55% alloys a single transformation from the same high temperature parent structure to a face-centered tetragonal structure. Metallographic observations indicate the transformation is martensitic. (H.D.R.)

43621 (COO–1198-473) SOME ASPECTS OF PHASE TRANSFORMATION IN NEAR-EQUIATOMIC NIOBIUM–RUTHENIUM ALLOYS. Das, Bijoy Kishore (Illinois Univ., Urbana). Aug. 1967. Contract AT(11-1)-1198. 64p. Dep. CFSTI.

Metallographic, magnetic, resistometric, and x-ray techniques were used to determine if a martensitic phase transformation from a CsCl-type parent phase to a phase having lower symmetry occurs in near-equiatomic Nb–Ru alloys, and, if so, to investigate the mechanism of such a transformation and the structure of the product phase. It was concluded that the alloys transform martensitically on cooling and the transformation temperatures decrease markedly with increasing Nb content. (H.D.R.)

43622 (COO–1198-477) DIFFUSION ALONG EDGE DISLOCATIONS IN Ni–Co ALLOYS. Baker, C.; Wuttig, M.; Birnbaum, H. K. (Illinois Univ., Urbana). Aug. 1967. Contract AT(11-1)-1198. 24p. (CONF-670909-5). Dep. CFSTI.

From International Conference on the Strength of Metals and Alloys, Tokyo, Japan.

A single 40% Ni–60% Co crystal was grown and a thin ^{63}Ni plate was deposited on one of the $(\bar{1}\bar{2}1)$ faces. Diffusion anneals were carried out and the activity at the nonplated exit face monitored with time. Dislocation diffusion data were obtained for edge dislocations in the range 620 to 500°C, and the plot was found to fit more closely the curve calculated using a time-dependent boundary condition rather than a Green's function source. Dislocation diffusivities and dislocation radii were calculated and the following equation obtained: $D_p = 3.4\ (cm^2 sec^{-1}) \exp -30.2\ (kcal\ mole^{-1}/RT)$. The dislocation structure of the 40 Ni–60 Co alloy (stacking fault energy = 30 ergs/cm^2) is discussed. The observations are consistent with enhanced diffusion occurring along the stacking faults as well as along the partial dislocation cores, and with a vacancy exchange mechanism. The ratio of dislocation and lattice diffusion activation energies Q_p/Q_l is shown to be greater than 0.5 for high-stacking-fault-energy metals and less than 0.5 for low-stacking-fault-energy metals. (D.L.C.)

43623 (COO–1198-478) INTERACTION OF A SURFACE COATING WITH EDGE AND SCREW DISLOCATIONS IN ZINC CRYSTALS. Lin, Ch'i-fan; Metzger, M. (Illinois Univ., Urbana). Aug. 1967. Contract AT(11-1)-1198. 23p. (CONF-670909-6). Dep. CFSTI.

From International Conference on the Strength of Metals and Alloys, Tokyo, Japan.

Square 45° Zn crystals were oriented so that polycrystalline Cu or Cr coating on $(1\bar{1}00)$ or $(33\bar{6}\ 11)$ faces would serve as obstacles to primary dislocations in screw or edge orientation. Evidence indicated that in general the surface layers of Zn under the coating were distorted more than the interior and the observed effects on strength and ductility were connected with the presence of a hard external layer. Distinction was made between "thin" coatings, where basal slip penetrated this layer, and "thick" ones, where the mode of deformation in the layer (not generally identified) was different. A classification based on this distinction was given of the complex variation of strengthening and loss of ductility with edge and screw obstacles and with coating type and thickness. Some of the differences between the effects for edge and screw dislocations were attributed to differences in mean free path. (auth)

43624 (IS-T-180) PLASTIC DEFORMATION BEHAVIOR OF LONG RANGE ORDERED IRON–ALUMINUM ALLOYS. Leamy, Harry John (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 166p. Dep. CFSTI.

Thesis.

The plastic deformation behavior of long range ordered alloys of Fe and Al has been examined by means of compressive deformation testing and transmission electron microscopy. Alloys in the range of compositions studied, 22.0 to 30.6 at. % Al, exhibit marked temperature and composition variations in deformation behavior. These variations have been attributed to functional dependencies of the nucleation and interaction of superlattice dislocations upon temperature and antiphase boundary (APB) energies. Single and polycrystalline flow stress curves indicate that, in the temperature range investigated (77°K to 573°K), low temperature deformation is accommodated by the motion of ordinary $\frac{1}{4}a_0\langle 111\rangle$ dislocations. Since these dislocations produce antiphase boundaries and cross slip rather easily, low temperature flow stress curves are characterized by high stress levels, short wavy slip lines, and nearly parabolic work hardening behavior. Deformation at higher temperatures is associated with the production of superlattice dislocations whose nucleation is aided by thermal fluctuations. The resultant flow stress curves are characterized by low yield stresses and from one to four linear work hardening stages. Further deformation in these proceeds by the motion of ordinary $\frac{1}{4}\ a_0\langle 111\rangle$ dislocations and the flow stress curve assumes the familiar parabolic form. Transmission electron microscopical observations of deformed single crystal sections indicate that the linear stages are produced by the interaction of superlattice dislocations of DO_3 (four APB coupled $\frac{1}{4}a_0\langle 111\rangle$ dislocations) type or B2 (two APB coupled $\frac{1}{4}a_0\langle 111\rangle$ dislocations) type. This unique deformation behavior has been treated theoretically on the basis of a simple model for superlattice dislocation nucleation and the work hardening processes have been discussed. (auth)

43625 (ORNL-P-3327) POTENTIOSTATIC METALLOGRAPHIC ETCHING EXPERIMENTS. Buhr, J. B.; Kegley, T. M. Jr.; Gray, R. J. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 34p. (CONF-670533-5). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

The potentiostat, which is an instrument for maintaining any desired electrical potential relative to a standard electrode, provides a means for maintaining a particular optimum potential at which a specific phase in the microstructure can be selectively etched electrolytically and differentiated from the remaining phases. The particular potential for optimum selectivity must be found experimentally, and the potentiostat aids in this by allowing the potential to be varied as desired. The experiments performed concerned the etching of two-phase alloys of tin and zinc in which little or no solid solubility is exhibited, the etching of austenitic stainless steels which contained ferrite, and which were free of ferrite, and the etching of heat treated type 310 stainless steel containing sigma phase. (auth)

43626 (ORNL-P-3336) APPLICATION OF ELECTRON METALLOGRAPHY TO PRECIPITATION STUDIES OF HASTELLOY N. Gehlbach, R. E.; Houston, J. T. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 11p. (CONF-670533-6). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

Various techniques available in electron metallography must be used to complement each other in order to gain a clear understanding of precipitation reactions. Besides transmission microscopy of thinned bulk samples, we have found that techniques for extraction of all precipitates in contact with a surface are important to reveal precipitates not observed in transmission or by usual replication techniques. Extraction replicas permit detection of sheets of very thin grain boundary precipitates as well as those seen by the usual techniques. Electron diffraction patterns may be easily obtained, without interference from the matrix, to get precipitate crystallography. The use of a microprobe attachment on the electron microscope permits qualitative identification of precipitates and, in many cases, a quantitative analysis. (auth)

43627 (UCRL–17711) FIELD ION MICROSCOPE STUDY OF THE Ta–Mo SYSTEM. Raghavan, Nathapet Varadachari Durai (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 102p. Dep. CFSTI.

Thesis.

A field ion microscope study of the tantalum-molybdenum system has been carried out at liquid hydrogen temperatures. The purpose of this investigation was twofold; the first being to increase the knowledge on the field ion microscopy of alloys with particular emphasis on how the solute affects the field ionization and field evaporation characteristics of the solvent atom, and the second being to categorize the segregation effects that become important at the high concentration levels to make the alloys brittle. For this purpose, a field ion microscope fitted with a cryo-tip that generates a small volume of liquid hydrogen was built. Micrographs have been obtained from three alloys of the composition Mo-8 Ta, Mo-50 Ta and Ta-12 Mo and from the two pure metals. The field ion specimens were obtained from crystals grown in an electron beam zone refiner by a combination of swaging and cold rolling or repeated spark cutting. The Ta-Mo alloy micrographs obtained show far more irregularity than those from W-Mo alloys. Physical and electronic factors have been shown to affect the nature of alloy micrographs. Field ionization and field evaporation processes in alloys have been discussed. The size differences in the two species forming the

alloys have been suggested to be responsible for the presence of bright spots. The greater regularity of the Mo-8 Ta micrographs over those from Ta-10 Mo has been shown to be in accord with predictions based on field evaporation from dilute alloys and the unexpected large difference in the regularity has been accounted for by considering the polarization and heat of solution terms in the field evaporation equation. Computer simulation of images from random and clustered alloys has been performed on the assumption that solute atoms do not participate in image formation. The far too great regularity of such computed images indicates that the total invisibility criterion is an oversimplification. A band structure results when deviations from randomness become appreciable in the clustered alloy. Contrast to be expected from a demixed alloy in the Ta-Mo system has been discussed but the available experimental evidence did not reveal such contrast effects. It has been concluded that the width of such demixed zones probably exceeds 1000 Å. However, a tendency for local clustering on the [200] planes was observed in the Ta-50 Mo alloy. (auth)

43628 ACTION OF ALKALI METAL VAPOURS ON THE TRIOXIDES OF MOLYBDENUM AND TUNGSTEN. Kessler, H.; Hatterer, A.; Herold, A. (Ecole Superieure de Chimie, Mulhouse, France). pp 465-73 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19-22, 1966. See CONF-660712.

The alkali metal vapors (M: Na, K, Rb, and Cs) react with MoO_3 and WO_3 under low pressure (10^{-2} mm of Hg) and below 500°C to give products with formula $M_{1.5+x}MeO_3$ where Me represents Mo or W. On heating, these products decompose into $M_2Me_2O_6$ and M gas. The thermal stability of K_2MeO_3 is determined with a thermogravimetric system. X-ray work and chemical properties study (reaction with water, alcohol, and liquid ammonia) show that these products are different from the known salts and "bronzes." (auth)

43629 TANTALUM–IRON SYSTEM. Raman, A. (Univ. of Illinois, Urbana). Trans. Indian Inst. Metals, 19: 202-5(Dec. 1966).

The Ta-Fe system has been investigated and the structures of the intermediate phases are explained. A μ phase is found to occur in the system and is found to be stable at compositions between 46 and 51 at. % Fe. $TaFe_2$ ($MgZn_2$) has a broad homogeneous field (64 to 72 at. % Fe). No other modification of the Laves phase is found to exist. The system is compared with that of Nb-Fe. The idea of considering the Laves phases as electron compounds related to the σ phase family is postulated. (auth)

43630 PHASE DIAGRAMS OF UCl_4–UO_2, UCl_4–$PbCl_2$, AND UCl_4–$MgCl_2$ SYSTEMS. Sterlin, Ya. M.; Artamonov, V. V. At. Energ. (USSR), 22: 473-8(June 1967). (In Russian).

The results of the study of the systems by means of thermal, x-ray structure, microscopic, and chemical analyses were reported. The phase diagrams of the systems UCl_4–UO_2, UCl_4–$PbCl_2$, and UCl_4–$MgCl_2$ were given. (tr-auth)

43631 NEW MICROCRYSTALLINE PHASES IN THE Nb–Ni AND Ta–Ni SYSTEMS. Ruhl, R. C.; Giessen, B. C.; Cohen, M.; Grant, N. J. (Massachusetts Inst. of Tech., Cambridge). Acta Met., 15: 1693-1702(Nov. 1967).

Utilizing the splat-cooling technique, Nb–Ni alloys with 33 to 78 at. % Ni and Ta–Ni alloys with 55 to 67 at. % Ni were rapidly quenched from the melt. The thin foils or flakes obtained were investigated by X-ray and electron diffraction. The diffraction patterns exhibited only broad maxima instead of relatively sharp crystalline peaks. Computer calculations based on several microcrystalline models were able to account for the features of the diffraction pattern in the region of the first maximum; best agreement was attained by assuming microcrystals of about 150 atoms in a body centered-cubic W-A2 type configuration (equivalent to spherical microcrystals 15 to 16 Å dia.). The microcrystalline structure persists for 1 hr at 600°C; at higher temperatures it decomposes into the equilibrium phases. In the Nb–Ni decomposition, a crystalline transition phase is first formed. The transformation of the microcrystalline Ta–Ni phase to $TaNi_2$ is regarded as an ordering reaction, combined with particle growth. A crystal-chemical relationship of the new microcrystalline phases to α-Fe may exist. (auth)

43632 KINETICS OF THE $\zeta \rightarrow \beta'$ TRANSFORMATION IN THE AgCdSYSTEM. Kittl, J. E.; Serebrinsky, H.; Gomez, M. P. (Comision Nacional de Energia Atomica, Buenos Aires). Acta Met., 15: 1703-14(Nov. 1967).

The $\zeta \rightarrow \beta'$ transformation in the Ag-Cd system was studied by means of electrical resistivity measurements and hot stage metallographic observations. From the resistivity results for temperatures below 150°C an apparent activation energy (Q = 16 kcal/mol) was calculated for growth of the β' phase. The same value for Q was also obtained from the hot stage results using the measurements of the ζ/β' interface velocity during isothermal experiments. This growth is likely to be controlled by the rate of transfer of atoms across the interface. From the transformation kinetics the exponent of the Johnson–Mehl–Avrami equation changes from $2 > n > 1$ at $T < 150$°C to $n > 4$ at $T > 180$°C. Agreement was obtained between these experimental results and predictions made by J. W. Cahn for the dependence of n on nucleation conditions. Interface morphology and relief marks resulting from the transformation are presented and discussed. The reaction has the characteristics of a massive transformation and the present quantitative data seem to support the idea that the massive reaction takes place by an interface controlled process. (auth)

43633 INTERNAL FRICTION AND TRANSMISSION ELECTRON MICROSCOPY STUDIES OF MAGNESIUM. I. INTERNAL FRICTION. Tsui, R. T. C.; Sack, H. S. (Cornell Univ., Ithaca, N. Y.). Acta Met., 15: 1715-22(Nov. 1967).

The internal friction of Mg was studied at 4 kc/s and 40 kc/s as a function of temperature (4.2 to 300°K), plastic deformation, crystalline orientation, heat treatment and impurity content. In pre-strained polycrystalline samples a peak was observed at 20°K which annealed out readily at 300°K, and a very broad peak between 40 and 240°K which showed a complex dependence on deformation and annealing. In deformed single crystals only the broad peak was found. The variation with orientation indicates that the peak is caused by dislocation motion in the (0001) slip system. The annealing behavior points to a possible dissociation of non-basal dislocations into basal and non-basal components. Addition of 1% Li suppressed both peaks, while Ni and Fe (which form precipitates) enhanced them. (auth)

43634 INTERNAL FRICTION AND TRANSMISSION ELECTRON MICROSCOPY STUDIES OF MAGNESIUM. II. ELECTRON MICROSCOPY. Tsui, R. T. C. (Cornell Univ., Ithaca, N. Y.). Acta Met., 15: 1723-30(Nov. 1967).

Thin film transmission electron microscopy and electron diffraction studies on pure and doped Mg were undertaken with the objective of correlating them with internal friction investigations. Small amounts (1%) of plastic deformation with slip primarily in the basal plane increased the dislocation density by a factor of about 100. The dislocations were generally very smooth and long. Hexagonal networks of dislocations were found, mostly in subgrains. $\{10\bar{1}2\}\langle 10\bar{1}1\rangle$ twins were found in specimens deformed by compression along the basal plane. Precipitates of Ni were observed and identified as $MgNi_2$. Pinning effects of Li and Ni were also studied. (auth)

43635 YTTRIUM DIFFUSION IN ZIRCONIUM. Fedorov, G. B.; Zhomov, F. I.; Smirnov, E. A. pp 22-4 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

It is shown that the coefficients and parameters of yttrium diffusion into α- and β-zirconium are close to those of zirconium self-diffusion. (R.V.J.)

43636 EFFECTS OF OXYGEN ADDITIVES ON THE STRUCTURE AND SUPERCONDUCTING PROPERTIES OF Zr–Nb ALLOYS. Bychkov, Yu. F.; Goncharov, I. N.; Khukhareva, I. S. pp 44-50 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Effects of O_2 impurities up to 0.25 wt % on the critical current density and disintegration of β-solid solution were studied with Zr alloys containing up to 33 wt % Nb. It was shown that O_2 additions increase the hardness and induce separation of β-solid solution into solution of 2 different concentrations. (R.V.J.)

43637 NIOBIUM–ZINC ALLOYS. Evstyukhin, A. I.; Godin, Yu. G.; Yakovleva, V. B. pp 51-9 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Preparation of low-melting and high-melting metals at low-boiling temperature was discussed and a method for thermal analysis was suggested. Data are given on the intermetallic compounds, $NbZn_3$, $NbZn_2$, Nb_2Zn_3, and NbZn. Phase transitions in Nb–Zn alloys above 1000°C demand special equipment in order to carry out the investigations at high pressures. (R.V.J.)

43638 THE DIFFUSION OF URANIUM IN TANTALUM AT TEMPERATURES EXCEEDING 2600°C. Taylor, George Bruce. Los Angeles, Univ. of California, 1966. 67p.

Thesis.

The diffusion couple of U metal in Ta was determined at 4280,

4490, and 4563 degrees Fahrenheit. The diffusion coefficients were measured by fitting the cylindrical diffusion equations for cylindrical diffusion with the experimental results. Since the diffusion depth was small compared to the radius of the cylinder, the linear approximation to the diffusion equation was also fit for comparison. At 4563 degrees F, the diffusion coefficient was 7.4×10^{-7} cm²/min with a deviation of −1.5 percent between the linear and cylindrical equations. At 4490 degrees F, the diffusion coefficient was 5.8×10^{-7} cm²/min with a deviation of +3.5 percent between the linear and cylindrical equations. Four samples were heat treated at 4280°F for 3.03, 5.00, 9.27 and 16.33 hours. The diffusion coefficient was 3.05×10^{-7} cm²/min with a coefficient of variation of 10.2%. The deviation of the diffusion coefficient calculated with the linear equation deviated +5.6 percent from that calculated with the cylindrical equation. The activation energy for the diffusion of U in Ta was calculated from the diffusion coefficients at three temperatures and equals 100.5 Kcal/mole. At 4290°F, the solid solubility of U in Ta was experimentally determined as 0.54 gram gram/cc ± 1.0%, and the solid solubility of Ta in U was experimentally determined as 0.00295 grams/cc ± 12%. In the presence of Ta, the threshold temperature for the reduction of U in UO_2 to U metal was above 3640°F and below 4290°F, as evidenced by the absence of U diffusion at 3640°F for ten hours of heat treatment. At temperatures above 4290°F, the U reduction was evidenced by large deposits of U metal at the interface of the diffusion couple. (auth)

Radiation Effects

43639 (AE–298) IRRADIATION EFFECTS AT 160 TO 240°C IN SOME SWEDISH PRESSURE VESSEL STEELS. Grounes, M.; Myers, H. P.; Hannerz, N-E. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Sept. 1967. 36p. Dep. CFSTI, SWED.

Tensile specimens, Charpy impact specimens, and miniature impact specimens of six steels in different conditions were irradiated to 2.8×10^{18} and 5.6×10^{18} n/cm² (>1 MeV) at 160 to 240°C. The steels investigated were SIS 142103, 2103/R3, NO 345, Fortiweld, Fortiweld HS, and OK 54 P. There was no correlation between the increase in transition temperature and initial transition temperature. However, changes in strength and ductility could be correlated to the initial yield strength. The increases in transition temperature due to strain aging and irradiation were approximately additive. The radio induced changes in 2103/R3 and Fortiweld HS steels did not vary with position in the thickness of the plate. Different tempering treatments in Fortiweld HS steel did not change the extent of the radiation effects. Normal Charpy V-notch impact specimens and miniature specimens gave the same radio induced increase in transition temperature. (auth) (SWEDEN)

43640 (BNWL–SA–1365) CLUSTERING OF IRRADIATION PRODUCED DEFECTS NEAR BOUNDARIES IN MOLYBDENUM. Mastel, B.; Brimhall, J. L.; Bierlein, T. K. (Battelle–Northwest, Richland, Wash. Pacific Northwest Lab.). July 27, 1967. Contract AT(45-1)-1830. 9p. (CONF-670819–1). Dep. CFSTI.

From 25th Annual Meeting of Electron Microscope Society, Chicago, Ill.

The effects of neutron radiation on the bcc metal Mo are presented. The microstructure of polycrystalline Mo irradiated at 600°C in 3.5×10^{19} n/cm² is compared to the microstructure of Mo irradiated at 60°C in 1×10^{19} n/cm². (D.C.C.)

43641 (EURAEC–1919) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Quarterly Report No. 7, April 1–June 30, 1967. Rossi, F. S. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). July 1967. Contract 074-65-10TEEI(RD). 8p. (EUR–3750). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The tensile properties of irradiated and unirradiated Ferrovac E and of unirradiated Fe-Ti alloy specimens at different temperatures and strain rates were measured. The secondary hardening peak was determined on unirradiated ASTM A212 base steels killed with Si, Al, Ti after quenching from 1100°C and tempering at 600°C. Tension data were compared with hardness tests and precipitated nitrogen concentration. Damage dosimetry studies with measurement of the irradiation induced modifications in Ultraperm magnetic properties were continued and some tests were also done to study the interaction of carbon and nitrogen atoms with the irradiation defects. Some electron micrographs were also done of replicas obtained from the broken tensile specimens of Ferrovac E and Fe-Ti alloys. (auth)

43642 (GEMP–544) OBSERVATION OF HELIUM BUBBLES IN AN IRRADIATED AND ANNEALED AUSTENITIC STEEL. Woodford, D. A.; Smith, J. P.; Moteff, J. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Aug. 25, 1967. Contract AT(40-1)-2847. 29p. (CONF-671010–1). Dep. CFSTI.

From American Institute of Mechanical Engineers Meeting, Cleveland, Ohio.

Post-irradiation transmission electron microscopy was performed on a split heat of a high temperature Fe base precipitation hardened alloy (A 286) containing 0.001 w/o and 0.010 w/o natural B. Irradiation was performed at reactor ambient temperature to a fluence of 4.8×10^{19} n cm^{-2} ($E_n > 1$ MeV) and 6.5×10^{20} n cm^{-2} (thermal). Following irradiation, individual specimens were then heat treated at 760, 845 and 955°C and examined by transmission electron microscopy. These studies show that all three heat treatments produced visible He bubbles. Analysis of the bubble sizes and size distribution indicates, for a given temperature, the higher B content alloy yields a larger mean bubble diameter. Also, the mean diameter increases with increasing anneal temperature for both B contents. Measurements and subsequent calculations of the observed He volume agrees quite well with what one would predict based on the ^{10}B atom concentration and thermal neutron fluence. The results of these studies also showed that virtually all of the He is associated with dislocations, and only a small fraction lies at grain boundaries or prime precipitate particles. These results indicate that a contributing factor to the observed radiation-induced embrittlement may be caused by bubbles pinning dislocations especially in areas adjacent to grain boundaries. This would restrict dispersal of stress concentrations at grain boundary triple points. Another significant observation is the presence of "shells" of He bubbles surrounding the precipitate particle TiN. The radii of the shells are approximately equal to the recoil distance of an α particle in an Fe matrix. (auth)

43643 (JUL–448–RW) DER EINFLUSS VON REAKTORBESTRAHLUNG AUF DAS AUSLAGERUNGSVERHALTEN EINER Al–4 PERCENT Cu-LEGIERUNG. (The Influence of Reactor Irradiation on the Structure Behavior in an Al–4 Percent Cu Alloy). Olshausen, K. D. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Jan. 1967. 103p. (In German). Dep.

Thesis.

An Al alloy with 4 wt % Cu after homogenization and quenching at 100, 150, 200, 250, and 300°C was placed in the reactor and the pattern of the electric resistance changes measured. An acceleration of diffusion after irradiation was not observed under the research conditions. At the beginning of the 100°C test a decrease in the formation velocity of the Guinier–Preston zones with respect to the measurements without radiation was noted. This could be explained through an accelerated recovery of the vacancies caused by the quenching during recombination with interstitial lattice atoms. This effect occurred in the 150°C test in the background with respect to another effect, namely the perturbation of the Θ'' zones formed by cascades after one to two days. After initial resistance-decrease, an increase was noted, which disappeared after several days when the formation of the larger and more stable Θ' phase began. In the temperature range from 200 to 300°C irradiation caused no conspicuous deviations since the Θ' phase was simultaneously separated out. A 25°C isotherm under electron irradiation showed an accelerated formation of Guinier–Preston zones detectable by an earlier occurring and more sharply increasing resistance increase. In this case an amplified diffusion arising through increased vacancy concentration was responsible for the effect. (107 References) (tr-auth)

43644 (LA–3737) BEHAVIOR OF LONG-LIVED FISSION PRODUCTS IN SODIUM. Clifford, J. C. (Los Alamos Scientific Lab., N. Mex.). June 1, 1967. Contract W-7405-eng-36. 9p. Dep. CFSTI.

Long-lived fission products have been introduced into a small, forced convection Na loop by immersing a trace-irradiated Pu alloy in the flowing Na. The distribution of Pu, ^{90}Sr, ^{137}Cs, and ^{155}Eu in the loop, over periods of 1000 to 3000 hr, has been observed by in situ gamma scanning of loop components and by radiochemical analysis of traps and metal specimens removed from the loop. Hot trapping, cold trapping, and graphite adsorber experiments have been conducted. (auth)

43645 (N–67–23280) RADIATION EFFECTS OF SILVER AND ZINC BATTERY ELECTRODES. Final Report, April 1965–October 1966. Nicholson, M. M.; Recht, H. L.; Argue, G. R. (Atomics International, Canoga Park, Calif.). Jan. 30, 1967. Contracts NAS7-100; JPL-951109. 50p. (NASA-CR–83552; AI–67-7). CFSTI.

Effects of γ radiation were investigated in experimental cells containing 40% KOH electrolyte. Cells were examined at radiation doses of 7×10^7 to 9×10^8 rads (H_2O) for changes in discharge capacity, gas evolution, and loss of electrode material.

For the Ag electrodes, pressure increases up to 0.8 atm, due primarily to the radiolytic evolution of H_2 and O_2, were observed at the same dose level in Ag test cells with Cd counter electrodes. Material losses from unsupported Ag–Ag_2O electrodes in flooded cells averaged 1.4% of the Ag electrode weight. An apparent increase in Zn discharge capacity during irradiation probably was caused by changes in the physical characteristics of the cellophane separator. H_2 evolution also occurred in Zn cells. Solid material losses were not directly measurable in the closely-packed starved-electrolyte design. Only gas evolution appears to present a special design requirement for Ag–Zn batteries in space applications. (auth)

43646 RADIATION EFFECTS ON SHEAR STRENGTH OF SEVERAL ALLOYS AT LIQUID HYDROGEN ENVIRONMENT. Weleff, W. (Aerojet-General Corp., Sacramento, Calif.). pp 544-56 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Shear strength properties data for ten alloys representing four families of materials were obtained at combined environment of liquid hydrogen and nuclear radiation (dose level approximately 5.6×10^{16} nvt, E > 1.0 MeV). Four specimens of each alloy were tested in double shear. Increase as well as decrease in sheer strength beyond threshold level of damage was found. All materials tested are suitable for application in liquid hydrogen at radiation doses up to 5.6×10^{16} nvt (E > 1.0 MeV). (auth)

43647 EFFECT OF NEUTRON RADIATION ON THE STRUCTURE AND PROPERTIES OF URANIUM ALLOYS CONTAINING 0.6 TO 9 PERCENT MOLYBDENUM. Dmitriev, V. D.; Ibragimov, Sh. Sh.; Karmilov, A. G. At. Energ. (USSR), 22: 459-65 (June 1967). (In Russian).

A series of uranium-alloy specimens containing 0.6 to 9.0% Mo was divided into two groups. One of the groups was subjected to homogenizing annealing at 950°C for 3 hr; the other group was extruded at the temperature of γ-phase and oil quenched. The specimens were sealed in steel ampuls and subjected to a thermal neutron flux radiation of $(0.5 \text{ to } 2.0) \cdot n/cm^2$. It was found that in almost all radiated specimens (except those containing 7 to 9% Mo), a phase transformation took place which was accompanied by changes in mechanical properties. The degree of these changes depended on both the Mo content and the initial structure of the alloys. As a result of radiation, the hardness of unalloyed α-U was increased by 50 kg mm^2; that of alloys containing 7 to 9% Mo radiated in γ-phase state practically did not change at all, while the hardness of specimens radiated in the α + γ-phase state was decreased by 55 to 60 kg/mm^2. The hardness of specimens containing 2.3 to 3.2% Mo extruded at 950°C and oil quenched increased more than 1.5 times after radiation. (ATD)

43648 HELIUM PRODUCTION BY (n,α) REACTIONS IN STAINLESS STEEL. De Pino, Andrew Jr. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Nucl. Appl., 3: 620-5(Oct. 1967). (BNWL-SA-639).

Calculations were made to estimate the amount of He generated by irradiating stainless steel in advanced fast and thermal reactors. The sources and rates of He production were determined for AISI type-304 stainless steel, a prime material for fuel cladding and reactor structural components. Reactor spectra were incorporated into the study to obtain more representative reaction rates in the two different reactors. Lack of cross-section data limits the accuracy of these calculations. Uncertainties in the estimates are presented, and the implications of the results are discussed. (auth)

43649 CALORIMETRIC MEASUREMENT OF RADIATION HEATING RATES IN A RESEARCH REACTOR. Cummings, Garth E. (Univ. of California, Livermore). Contract W-7405-eng-48. Nucl. Appl., 3: 641-5(Oct. 1967). (UCRL-70308).

Steady-state and adiabatic calorimeters were used successfully to measure radiation heating rates in lead and polyethylene samples in various facilities at the Livermore Pool-Type Reactor. With the steady-state calorimeter, rates were determined by the temperature difference across a known thermal resistance connecting the samples to a heat sink. The adiabatic calorimeter was used to determine heating rates by the rate of change of temperature in the sample at the time the sample and heat sink temperature were the same. The adiabatic calorimeters were easier to construct, but required more time for measurement. (auth)

43650 ASPECTS OF THE HIGH-TEMPERATURE IRRADIATION EMBRITTLEMENT IN STAINLESS STEELS. Waddington, J. S. (Central Electricity Generating Board, Berkeley, Eng.). Metal Sci. J., 1: 156- (1967).

It was found that irradiation increases the growth rate of wedge cracks in 20:25 Cr–Ni stainless steel. A fractographic study revealed the presence of small voids, 0.5 μm in dia, on irradiated fracture surfaces that were not apparent in the unirradiated samples. A model, appropriate for the discussion of wedge cracks, was used to correlate these observations. (auth) (UK)

Ceramics and Cermets

43651 CERAMIC FUEL ELEMENTS. An AEC Monograph. Holden, Robert B. Monograph Series on Metallurgy in Nuclear Technology. New York, Gordon and Breach, Science Publishers Inc., 1966. 244p. $12.50.

The preparation, properties, fabrication and performance of ceramic fuels are discussed. The fuels include: UO_2, uranium carbides, uranium nitrides, uranium silicide, uranium phosphide, uranium sulfide, PuO_2, plutonium carbide, plutonium nitride, ThO_2, thorium carbides, thorium mononitride, thorium monosulfide, and thorium monophosphide. (auth)

Preparation and Fabrication

Refer also to abstract 44960.

43652 (ORNL-TM-1980) LABORATORY STUDIES OF SOL–GEL PROCESSES AT THE OAK RIDGE NATIONAL LABORATORY. McBride, J. P. (comp.) (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 79p. (CONF-671008-3). Dep. CFSTI.

From Symposium on Sol–Gel Processes for the Production of Ceramic Nuclear Fuels, Turin, Italy.

Sol-gel processes are being developed for preparing the oxides, carbides, and nitrides of thorium, uranium, plutonium, zirconium, and their mixtures. The status of laboratory studies being made at the Oak Ridge National Laboratory (ORNL) in support of this effort is presented, and sol preparation, sol characterization, and drying and firing of gel products are described. Of the sol-gel processes studied, those involving the preparation of pure ThO_2 and ThO_2–3% UO_3 are the most advanced and most completely reported. Hence, only brief mention is made of these processes. In the interest of completeness, ORNL work on the sol-gel preparation of oxides of the rare earths and the transplutonium elements is referenced. (71 references). (auth)

43653 FORMATION OF SUBMICRON URANIUM CARBIDE PARTICLES IN METALLIC URANIUM. Last, George A.; Kemper, Robert S. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,346,673. Oct. 10, 1967.

A method of forming a fine dispersion of uranium carbide in uranium by dissolving carbon in molten uranium to obtain a concentration of 700 to 1000 ppM carbon in the uranium is described. Small droplets of the resulting solution are formed and then quenched to form solid shot. (AEC)

Properties Evaluations

Refer also to abstracts 42914 and 43614.

43654 (AD-651435) REFRACTORIES IN A REACTIVE ATMOSPHERE. Long, L. C.; Joiner, James R. (Air Force Flight Dynamics Lab., Wright-Patterson AFB, Ohio). Apr. 1967. 39p. (AFFDL-FDTR-TM-67-1). CFSTI.

Various refractory materials were examined with respect to their oxidation behavior and reactivity with water vapor. The materials were initially chosen based on the criterion that they exist in solid form above 2000°C. The substances include metals, intermetallics, borides, carbides, nitrides, single and mixed oxides, silicides, sulfides, phosphides, and oxysulfides. Two hundred fifty-eight materials are listed. Primary coating materials were chosen on the basis that each metal or compound: existed in a solid state from 0°C to greater than 2000°C, experienced no catastrophic oxidation in still air below 1700°C, and exhibited no observable reaction with water vapor. Nine materials satisfied these conditions: ThO_2, HfO_2, ZrO_2, $ZrSiO_4$, Cr_2O_3, WSi_2, $CaCr_2O_4$, Ti_2O_3, and α-Al_2O_3. These are listed in the order of decreasing melting point with the exception of Ti_2O_3, whose quoted temperature is one of decomposition. Secondary coating materials totaling 34 were those for which insufficient data were available to be able to determine whether they could be acceptable coating materials. All other materials were found to have questionable suitability for use as coating materials under the conditions specified. (auth)

43655 (AI-CE-41) HEAVY WATER ORGANIC COOLED REACTOR. METALLURGICAL EVALUATION OF DISPERSION STRENGTHENED ALUMINUM ALLOY BILLET MATERIAL. Nagel, W. E. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Sept. 15, 1967. Contract AT(38-1)-430. 93p. Dep. CFSTI.

Dispersion strengthened Al alloys were selected as the fuel cladding and pressure tube materials for the Heavy Water Moderated Organic Cooled Reactor (HWOCR). With the inception of the HWOCR Program, large quantities of Al–7Al_2O_3 and Al–10 Al_2O_3 alloy billet were procured for fabrication into tubing. A metallurgical evaluation was performed to permit establishment of the level and variability of certain metallurgical characteristics. The characteristics determined were room and elevated temperature, mechanical properties, chemical composition, macrostructure and microstructure, and internal soundness. This type of information was obtained to supplement the limited data normally generated by supplier acceptance testing for quality control purposes. The evaluation also resulted in a comparison of Al-alumina billets produced by two suppliers. In general, the results of the evaluation demonstrated that the billet met the mechanical property and chemical composition requirements of the procurement specification. Ultrasonic and structural studies indicated that soundness in the billet material from one of the suppliers was considerably better than from the other. (auth)

43656 (IS-T-181) EMITTANCE OF URANIUM OXIDES. Held, Peter Christian (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 55p. Dep. CFSTI.

Thesis.

Hemispherical spectral emittances were measured for uranium oxides. The compositions ranged from $UO_{1.35}$ to $UO_{2.29}$, the densities from less than 8.0 to more than 10.6 g/cm³, the porosities from less than 0.5 to more than 19.0%, and the temperatures from about 450 to about 2400°K. The data were taken at two wave lengths, 0.656μ and 0.70μ. It was found that the emittance in all cases is high ranging from about 0.70 to 0.88. The emittance was not found to be systematically sensitive to temperature, porosity, density, or surface finish and to be only slightly sensitive to stoichiometry. The high emittance values are linked to the adsorption edge observed for uranium oxides in the visible portion of the spectrum. A more refined analysis of the absorption mechanism must await a resolution of the fine structure in the absorption edge. (auth)

43657 (LA-DC-8411) HUGONIOTS OF GRAPHITES OF VARIOUS INITIAL DENSITIES AND THE EQUATION OF STATE OF CARBON. McQueen, R. G.; Marsh, S. P. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 8p. (CONF-670914-12). Dep. CFSTI.

From International Symposium on the Behavior of Dense Media Under High Impulsive Pressures, Paris, France.

The Hugoniot equation of state of several graphites and diamond was measured using the shock-wave impedance-match technique. The graphites tested were pyrolytic, pressed (3 compositions), ZTA, ATJ, and PT 0178. The results are tabulated and plotted as shock-particle velocity and pressure-density Hugoniot graphs. The low, intermediate, and high pressure ranges are discussed. Other measurements are also described. (D.L.C.)

43658 (NUMEC-3524-31) DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS. Progress Report, October 1, 1966–December 31, 1966. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Aug. 1967. Contract AT(30-1)-3524. 29p. Dep. CFSTI.

The 30,000 MWD/Te and 60,000 MWD/Te burnup capsules were inserted into EBR-II Mark 1 and loaded into the reactor grid. These fuel rods have undergone two EBR-II cycles. The previously loaded 100,000 MWD/Te burnup rods have completed four EBR-II cycles. The pertinent operating data for the individual fuel capsules are summarized from computer runs. The work involving a powder heat treatment approach to density control has been completed. Coprecipitated 20 wt % PuO_2-UO_2 powder was heat-treated at 1,200, 1,400, and 1,600°C for one hour in a N_2-6 vol % H_2 atmosphere. This powder was then mixed into compositions containing from 0 to 75% of the untreated powder and the green pellets produced from this material were run through a normal firing cycle. A light etching second phase has been observed in certain of the 20 wt % PuO_2-UO_2 fuels being irradiated in EBR-II. The experimental system for the preliminary measurement of o/m ratio has been checked out by the quantitative oxidation of UO_2 to U_3O_8. Spectrographic analyses of metallic impurities of plutonia-urania compositions were made. A comparison of the metallic impurity analyses for the starting plutonium and for the purified product is given. (J.C.W.)

43659 CERAMIC-METAL COMPOSITES: NUCERITE. Wood, W. (Balfour Group, Leven, Scotland). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 193-9(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13–14, 1965. See CONF-651089.

'Nucerite,' a new material of construction consisting of a ceramic–metal composite which has improved mechanical strength and abrasion resistance over glassed steel is described. A wide range of ceramics is available and these can be bonded to a range of base metals, thus giving a very wide choice of properties. An outline of the induced crystalline structure in the ceramic shows how Nucerite is suitable for high temperature use together with good corrosion resistance. The application of Nucerite in the chemical and related industries shows how its versatility can be used to solve high temperature, corrosion, and abrasion problems. Examples of items of equipment, together with the conditions under which they are being used, confirm that there is a big future for Nucerite as it is developed and its properties are improved even further. (auth)

43660 ELECTRIC CONDUCTIVITY OF ZrO_2 WITH Cu_2O. Dereberya, N. A. (Ukrainian Printing Inst., Lvov). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1895-6(Oct. 1966). (In Russian).

Results of the measurement of the electric conductivity of ZrO_2 with Cu_2O showed that sintered ZrO_2 with Cu_2O has hole conductivity, the magnitude of which depends on the temperature, the partial pressure of oxygen, and the quantity of Cu_2O impurity. (tr-auth)

43661 ELECTRIC CONDUCTIVITY OF SOLID SOLUTIONS OF CALCIUM OXIDE IN ZIRCONIUM DIOXIDE AT ELEVATED TEMPERATURES. Ezerskii, M. L.; Kozlova, N. I.; Bagotskii, V. S.; Kalliga, G. P.; Demonis, I. M.; Rastorguev, L. N.; Prilepskii, V. I. Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1811-15 (Oct. 1966). (In Russian).

The electric conductivity of annealed ceramics of stabilized ZrO_2 was investigated in relation to temperature, concentration of calcium oxide, degree of purity of ZrO_2, and method of stabilization. An x-ray-structural analysis of the solid solution ZrO_2–CaO was made. By means of the analysis the boundary of homogeneity of the cubic solid solution was established. The presence of superstructure in the samples with CaO $\gg$ 15 mol % was also established. On the basis of data obtained from the x-ray-structural analysis, an attempt was made to explain the dependence of the electric conductivity on the CaO concentration in solid solutions of ZrO_2–CaO. (tr-auth)

43662 HIGH-TEMPERATURE OXIDATION. IV. ZIRCONIUM AND HAFNIUM CARBIDES. Berkowitz-Mattuck, Joan B. (Arthur D. Little, Inc., Cambridge, Mass.). J. Electrochem. Soc., 114: 1030-3(Oct. 1967).

The oxidation of ZrC was studied at temperatures of 1130 to 2160°K and oxygen partial pressures around 3.9 and 20 Torr. The rate of oxidation was monitored with a thermal conductivity cell. Independent measurements were made of net weight gain and quantities of CO(g) and CO_2(g) evolved. Oxidation was shown to be nonpreferential, i.e., Zr was oxidized at the same rate as C. Gas phase diffusion control imposed by the experimental system was frequently encountered. Where it was possible to observe a true chemically controlled reaction rate, the kinetics appeared to be linear. Microscopic examination of the oxidized specimens revealed preferential oxidation along grain boundaries. Between 1130 and 1560°K this preferential oxidation resulted in intercrystalline fracture. At higher temperatures stresses were apparently sufficiently relieved so that the samples remained intact. The oxidation of HfC between 1790 and 2000°K, at oxygen pressures near 10 Torr, was also found to be linear and preferential along grain boundaries. (auth)

43663 THE EFFECTS OF DOUBLE INSULATING LAYERS ON THE ELECTROLUMINESCENCE OF EVAPORATED ZnS:Mn FILMS. Russ, M. J.; Kennedy, D. I. (Bowmar Canada Ltd., Ottawa). J. Electrochem. Soc., 114: 1066-72(Oct. 1967).

The performance of ZnS: Mn electroluminescent layers deposited between double SiO insulating films is described. The dependence of emission properties on SiO and ZnS film thickness and Mn content are outlined. The relatively bright (700 ft-L) and efficient (1 lpw) emission is interpreted in terms of excursions from equilibrium trap occupation under high field conditions. (auth)

43664 OXYGEN DIFFUSION IN CoO AS MEASURED BY PROTON ACTIVATION OF ^{18}O. Holt, J. Birch (Univ. of California, Livermore). Proc. Brit. Ceramic Soc., No. 9, 157-70 (July 1967).

The volume diffusion of oxygen was measured in single-crystal and bicrystal CoO. The crystals were annealed in oxygen enriched with ^{18}O at temperatures ranging from 1000° to 1500°C. The ^{18}O was activated by 2.8 MeV proton irradiation to produce radioactive ^{18}F. Autoradiographs offered evidence of preferential diffusion of oxygen at grain boundaries. Penetration profiles for bulk diffusion were obtained by the sectioning method, and from microdensitometer traces of autoradiographs exposed from bevelled samples. The diffusion coefficients are compared with those derived from gaseous exchange data, and the discrepancies are discussed. (auth) (UK)

43665 TEMPERATURE DEPENDENCE OF CARBON DIFFUSION COEFFICIENT IN NON-STOICHIOMETRIC ZIRCONIUM, NIOBIUM, AND TANTALUM CARBIDES. Vil'k, Yu. N.; Nikol'skii, S. S.; Avarbe, R. G. (State Inst. of Applied Chemistry, USSR). Teplofiz. Vys. Temp., 5: 607-11(July-Aug. 1967). (In Russian).

Carbonization of cylindrical specimens of zirconium, niobium, and tantalum non-stoichiometric carbides from carbon carrying gas media was used as a method for evaluating averaged coefficients at 2100 to 2900°K. It was revealed that the diffusion of carbon atoms into monocarbide phases of transition metals of the IV and V groups is hindered and is much slower than in primary solid solutions. Crystalline lattice parameters of transition and maximum carbon saturated metals of the IV and V groups are tabulated. (R.V.J.)

43666 VAPORIZATION STUDIES OF U DIOXIDE AND CARBIDES. Gorban, Yu. A.; Pavlinov, L. V.; Bykov, V. N. At. Energ. (USSR), 22: 465-9(June 1967). (In Russian).

The vapor pressure over UO_2 and UC was determined by the differential variant method of Knudsen. For UO_2 there was a dependence between the changes of the composition with respect to O_2 and the temperature of the isothermal stability. The heat and free energy of evaporation were determined as a function of the dependence of the vapor pressure on the temperature in the range from 1,600 to 2,300°C. The evaporation of UC in a vacuum occurs with loss of C during which the heat of dissociation does not depend on the concentration of the bound C. The presence of free C decreases the volatility of the monocarbide. (tr-auth)

43667 MAGNETIC PROPERTIES OF URANIUM SELENIDES AND SULFIDES. Chechernikov, V. I.; Pechennikov, A. V.; Yarembash, E. I.; Martynova, L. F.; Slavyanskikh, V. K. (Moscow State Univ.). Zh. Eksp. Teor. Fiz., 53: 498-503(Aug. 1967). (In Russian).

The magnetic properties of uranium selenides and sulfides with a stoichiometric composition 1:1.3:4.2:3.3:5.1:2 are studied. The investigation is carried out between 77 and 1000°K at various magnetic field strengths. In the investigated temperature range the USe_2 and U_3S_5 compounds are found to be paramagnetic with $\Theta_p < 0$. The other compounds are ferromagnetic. The $\sigma(T)$ curve for USe exhibits a peak which shifts towards lower temperatures (from 156 to 135°K) with increasing H and which disappears at H = 7 kOe. The paramagnetic susceptibility of the USe_2 and U_3S_5 compounds obeys the Curie–Weiss law. In the other compounds this law is observed only in a restricted temperature range. (auth)

43668 FLOW OF GASES IN POROUS SOLIDS. Hawtin, P.; Hewitt, G. F.; Roberts, J. (Atomic Energy Research Establishment, Harwell, Eng.). Nature (London), 215: 1415-16(Sept. 23, 1967).

Approximate equations were developed for the flow of binary mixtures of gases through porous media. The model was developed for the flow of binary mixtures of gases through porous media. The model was developed for a single capillary, assuming that the molar flux of each gas through the capillary is the sum of three terms: a diffusion flux, which results from the statistical movement of the molecules under the partial-pressure gradient; a viscous flux resulting from the general motion of the gas induced by the total pressure gradient; and a net drift flux, which arises from momentum transfer requirements within the capillary tube. The method of application is by using overall constants for the media, rather than by considering individual pores. The foregoing treatment was verified using reactor-grade graphite as the porous medium, and N_2–He and Ar–He as gas pairs, in counter diffusion runs. Measurements were made over the temperature range from 20 to 600°C at a total mean pressure of ~1 atm., with applied differential pressures between –1 and +12 mm. Hg. These applied pressure differences yielded flux ratios between 0.1 and 10. At zero total pressure difference the observed flux rates for the two gas pairs were close to the theoretical values of 0.377 for N_2–He and 0.317 for Ar–He. It is concluded that the theory provides a good approximation to the actual behavior of the system. (UK)

43669 EFFECTS OF ISOCHRONOUS AND ISOTHERMAL ANNEALING ON THE HARDNESS OF DEFORMED URANIUM OF VARIOUS PURITIES. Tsvetaev, A. A.; Chuzhko, R. K.; Bovenko, V. N.; Golovanov, Yu. N. pp 105-10 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The maximum of restored isochronous hardness depends on the deformation aging processes. The recovered hardness at t >300°C results from self-diffusion. The energy of α-U self-diffusion is U_0 = 45,000 cal/mol. (tr-auth)

43670 A SOL-GEL THORIUM OXIDE WITH IMPROVED DISSOLVING CHARACTERISTICS. Russell, E. R.; Hyder, M. L.; Prout, W. E.; Goodlett, C. B. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Nucl. Sci. Eng., 30: 20-24(Oct. 1967). (DP-MS-66-24).

The dissolving rate of sol-gel ThO_2 is increased three- to six-fold when approximately 1 wt % MgO is incorporated into the ThO_2. The MgO is introduced by adding an $Mg(NO_3)_2$ solution to the ThO_2 sol. ThO_2 containing MgO is suitable for use in reactor targets. Dissolving rates were increased under all preparative conditions investigated; density and physical properties were also satisfactory. The oxide retained its improved dissolving characteristics following irradiation in a reactor. The preparation of the ThO_2–MgO was demonstrated by the production of 500-lb batches in commercial equipment. (auth)

43671 METHOD FOR MELTING URANIUM OXIDE AND PLUTONIUM OXIDE. Schikarski, Lother; Teiwes, Hans-Jurgen (to U. S. Atomic Energy Commission). U. S. Patent 3,346,346. Oct. 10, 1967.

A process for melting a charge of fine oxide powders of PuO_2, UO_2 or mixtures thereof, is described that comprises placing in the center of a vacuum-tight crucible a column of relatively conductive material such as graphite, compacts of the powder to be melted or a residue of previous melting. The column is surrounded with the powder charge and contacted with a heating electrode that is energized to create a vertical path of current in the column axially of the powder charge. The current is maintained until an electrically conductive column is created in the oxide powder charge, the column is then removed if of a material different from the powder charge. The electrical current is increased and maintained until a substantial part of the powder charge is fused substantially free of vaporization. (AEC)

Structure and Phase Studies

43672 ON EFFECTIVE THERMAL CONDUCTIVITY AND STRUCTURAL CHANGE OF UO_2 POWDER COMPACTED FUEL IN THERMAL SIMULATION EXPERIMENT. Aoki, Sigeo; Kobayashi, Yukio; Sato, Kenji (Furukawa Electric Co., Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 408-14(Aug. 1967).

The effective thermal conductivity K_{eff} of powder compacted UO_2 fuel material under simulated thermal conditions of a reactor and structural changes brought about by large thermal gradient at elevated temperatures are described. From the results obtained, it is concluded that: structural change in the material occurring under such thermal conditions greatly affects K_{eff}, which is thereby increased as a result of columnar grain growth; columnar grains developed the path of heat flow are single crystals growing in the direction ⟨111⟩; K_{eff} is higher when measured during cooling than during heating, and the relation between K_{eff} and temperature is similar to the case of a UO_2 single crystal; K_{eff} measured in 90% He 10% H_2 at atmospheric pressure is much higher than in vacuum, from which it can be inferred that the gas contained in the fuel pin has marked influence on K_{eff}. (auth)

43673 POINT DEFECTS IN CERAMICS. Lidiard, A. B. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 9, 1-14(July 1967).

Recent progress in the study of point defects in ceramics is reviewed. Attention is given to: (1) the identification of defects in ESR and by optical methods (Faraday rotation and stress splitting of zero-phonon lines); (2) the verification of defect structure by relaxation measurements; (3) the interrelations of defects in mass transport properties; and (4) the interpretation of radiation damage work. (auth) (UK)

43674 RELAXATION PROCESSES IN SINGLE-CRYSTAL UO_2. Socino, G.; De Batist, R.; Gevers, R. (SCK-CEN, Mol, Belg.). Proc. Brit. Ceramic Soc., No. 9, 73-82(July 1967).

In the internal friction spectrum of UO_2 single crystals, relaxation peaks appear between room temperature and –50°C for a frequency of about 1000 Hz. The value of the activation energy for the process (approximately 0.47 eV) leads to the hypothesis that the peaks are caused by a reorientation of oxygen atoms incorporated interstitially in the UO_2 lattice. The orientation dependence of the relaxation strength, and the various relaxation frequencies, were calculated for a model defect having the same strain tensor orientation as the oxygen interstitial (i.e., with main axis along a ⟨113⟩ direction). The experimental data are compared with the results of this theory. (auth) (UK)

43675 CRYSTAL CHEMISTRY OF AB_2 STRUCTURES. I. INVESTIGATIONS ON AB_2 SECTIONS IN THE TERNARY SYSTEMS RARE EARTH–ALUMINUM–SILICON, –GERMANIUM,

AND –TIN. Raman, A.; Steinfink, H. (Univ. of Texas, Austin). Inorg. Chem., 6: 1789-91(Oct. 1967).

Seven ternary AlB_2-type phases were found in the systems La–Al–X, Ce–Al–X, and Nd–Al–X, where X stands for the elements Si, Ge, or Sn. The AlB_2-type structure was found to occur at valence electron concentrations between those required for the Laves phases and for the $ThSi_2$-type structure. The AB_2 structures investigated in the rare earth alloys form the following sequence with increasing valence electron concentrations: $MgCu_2 \rightarrow AlB_2 \rightarrow ThSi_2 \rightarrow GdSi_2$. The AlB_2-type phases were found to have anomalously higher volumes per atom than the $MgCu_2$- or $ThSi_2$-type phases. (auth)

43676 CONSTITUTION DIAGRAM OF THE UC–W AND URANIUM DIFFUSION FROM MONOCARBIDE INTO TUNGSTEN. Evstyukhin, A. I.; Fedorov, G. B.; Solov'ev, G. I.; Smirnov, E. A.; Zhomov, F. I.; Zaluzhnyi, A. G. pp 99-104 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

The constitution diagram of UC–W is a eutectic type with a limited solid-state solubility. The eutectic melting point is 2160 ± 20°C (in alloys with 10 wt % W). U diffusion from the UC into W was studied at 1500 to 2100°C. The diffusion coefficient as a function of the temperature is expressed as: $D = 0.11 \times \exp(-91{,}700/RT)$ cm²/sec. It was found that UC does not react with W at examined temperature range. (tr-auth)

43677 ZIRCONIUM–CARBON SYSTEMS. Godin, Yu. G.; Evstyukhin, A. I.; Emel'yanov, V. S.; Rusakov, A. A.; Suchkov, I. I. pp 25-32 of Metallurgiya i Metallovedenie Chistykh Metallov. Vypusk V. Emel'yanov, V. S.; Evstyukhin, A. T. (eds.). Moscow, Atomizdat, 1966. (In Russian).

Physicochemical analysis was made of Zr–C system and constitution diagram was constructed for single-phase ZrC and double-phase β + ZrC and C + ZrC systems. (R.V.J.)

Radiation Effects

Refer also to abstract 44190.

43678 ANALYSIS OF THE ESCAPE BEHAVIOR OF XENON CAPTURED IN GRAPHITE BY NUCLEAR RECOIL. II. ISOTHERMAL ANNEALING. Iwamoto, Kazumi (Japan Atomic Energy Research Inst., Tokyo); Oishi, Jun. J. Nucl. Sci. Technol. (Tokyo), 4: 431-42(Aug. 1967).

The escape of ^{133}Xe introduced into natural graphite by recoil from UO_2 particle was studied at temperatures ranging from 200° to 1,450°C and the resulting data correlated with the duration of isothermal post-irradiation heating. The escape data were used to verify the proposed escape mechanism, which postulates three successive processes—release from trapping site, diffusion of the released xenon, and desorption from surface. The concept of initial activation energy spectrum, which determines the trapping states of xenon atoms before any annealing begins in terms of the activation energy for the release, was introduced to express the release behavior mathematically. The mathematical treatment for both the release and the diffusion processes permits expression of the whole escape process with a single equation, assuming no resistance to xenon transport in the desorption process. The validity of this equation was substantiated by observed data. It was made clear that rapid sweep of the spectrum is the cause of the initial burst stage in which the escape rate is dependent upon diffusion of the released xenon, and that the slow sweep of the spectrum causes the ensuing slackened process in which the release from the trapping sites constitutes the limiting factor for the rate of escape. (auth)

43679 RADIATION DAMAGE IN ZIRCONIA. Harrop, P. J.; Wilkins, N. J. M.; Wanklyn, J. N. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 9, 279-86(July 1967).

A general study of gamma, neon, and neutron damage to zirconia films is briefly summarized, with particular attention to those cases where effects have been observed. These include sputtering and changes of electrical conductivity wrought by 65-keV neon, and electrical, optical, and mechanical changes caused by reactor neutrons. Some crude estimates of point-defect population were made, and it is concluded that zirconia is broadly similar to other oxides in its behavior. (auth)

43680 ELECTRON SPIN RESONANCE IN NEUTRON-BOMBARDED GRAPHITE. Harker, H.; Horsley, J. B. (Univ. of Newcastle-upon-Tyne, Eng.). Phil. Mag., 16: 23-33(July 1967).

The variations of signal intensity, produced on progressive irradiation or progressive annealing, were roughly parallel to changes of the interlayer spacing; this supports the idea that the radioinduced unpaired electrons are associated mainly with interstitial defects, as contended by Hennig and Hove [Int. Conf. Peaceful Uses Atom. Energy (Geneva), 1955] and by Mrozowski [Carbon, 3: 305, 1966], rather than new charge carriers as believed by Müller [Proc. XIth Colloque Ampere, 1963]. Further evidence is discussed, which leads to the conclusion that the free spins may be situated on small interstitial-groups rather than the large clusters visible in the electron microscope. They do not appear to be confined to single interstitials, however, as Hennig and Hove originally suggested, otherwise simpler annealing kinetics would have been encountered. The contribution that vacancies make to the ESR signal is surprisingly small. (auth) (UK)

Plastics and Other Materials

Refer also to abstracts 43649 and 44200.

43681 (ORNL-P-3338) METALLOGRAPHIC PREPARATION OF CERIUM CARBIDES. Kegley, T. M. Jr. (Oak Ridge National Lab., Tenn.). [1967]. 15p. (CONF-670533-7). Dep. CFSTI.

From 21st AEC Metallographic Group Meeting, Upton, N. Y.

Special procedures were required to prepare CeC_2 metallographically because of their strong reactivity with moisture. A chemical, an electrolytic, and a protective-oil method were developed for preparing these carbides for examination. In both the chemical and electrolytic methods a stainless steel screw served as a contact with the CeC_2. CeC_2 is either chemically polished or passivated by immersion in equal parts acetic, lactic, and nitric acids depending upon whether the mount is partially or totally immersed. If the CeC_2 specimen is partially immersed so that the stainless steel screw does not contact the solution, only chemical polishing takes place. If the mounted specimen is totally immersed, a galvanic cell is created such that CeC_2 is the anode and stainless steel is the cathode. The emf developed by this cell provides the necessary potential for passivation of the CeC_2. In the electrolytic method the CeC_2 was anodized at 5 v for 10 sec in equal parts acetic, lactic, and sulfuric acids. In the protective-oil method CeC_2 was chemically polished in acetic-lactic-nitric acids and then washed with ethyl alcohol. Silicone oil was added to displace the ethyl alcohol, and a cover glass was placed on the CeC_2 specimen. For two-phase specimens containing CeC_2 and Ce_2C_3, the protective-oil procedure was followed but with the exception that chemical polishing was not employed. (auth)

43682 NON-METALLIC CONTAINMENT MATERIALS FOR ALKALI METALS AND THEIR COMPOUNDS. Reed, L. (EIMAC, San Carlos, Calif.). pp 45-52 of The Alkali Metals. London, The Chemical Society, 1967.

From International Conference on the Alkali Metals, Nottingham, Eng., July 19–22, 1966. See CONF-660712.

Viewpoints of single crystal alumina (sapphire) and single crystal magnesia (periclase) are described for optical studies of alkali metals and their compounds. In order to develop full usefulness of non-metallics for container materials, a seal to a metal member is often used. The development of several ceramics, metals, and sealing techniques for elevated temperature containment systems of the alkali metals and their compounds is presented. (D.C.C.)

43683 THERMAL CONDUCTIVITY OF BEDS OF COATED FUEL PARTICLES. Stevens, D. W. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-633. Nucl. Appl., 3: 626-34(Oct. 1967). (GA-7241).

The thermal conductivity of loose, pyrolytic carbon-coated fuel particles in He was studied at temperatures from 1800 to 2700°F using a convenient comparative technique. The conductivities of coated particles with both 150- and 795-μm overall diameters were shown to rise and then remain constant as the He pressure was increased to 4 atm. Measurements using particles with various coating thicknesses and structures indicated that bed conductivity was relatively insensitive to the properties of the coating. (auth)

43684 CHANGES PRODUCED IN THERMOELECTRIC MATERIALS BY THERMAL-NEUTRON IRRADIATION. Idnurm, M.; Landecker, K. (Univ. of New England, Armidale, New South Wales). Brit. J. Appl. Phys., 18: 1209-11(Aug. 1967).

The effects of thermal-neutron irradiation on the parameters involved in the thermoelectric figures of merit of Bi_2Te_3 and its thermoelectric alloys were examined. It was found that integrated fluxes of up to 2×10^{18} neutrons/cm² are not sufficiently high to affect the figures of merit of these materials by the introduction of radioinduced photon scattering centers. On the other hand, the results indicated that if still higher fluxes were employed it

would become necessary to resort to excessive counter-doping in order to maintain the carrier densities in the materials at the optimum values. (auth) (UK)

43685 REACTOR ORGANIC COOLANTS. II. ELECTRON-IRRADIATION STUDIES OF HYDROGENATED TERPHENYLS. Tomlinson, M.; Tymko, R. R.; Wuschke, Donna (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Nucl. Sci. Eng., 30: 14-9(Oct. 1967).

The hydrogenated terphenyl mixture HB-40 which is in use as a reactor organic coolant has been irradiated at 350°C with 1.5-MeV electrons. Changes in composition and properties are reported. Decomposition proceeded at half the rate per unit dose observed previously during reactor irradiations where 62% of the absorbed energy was due to fast neutrons. This indicates a dependence of hydroterphenyl radiolysis on Linear Energy Transfer, whereby recoil protons produce 3.2 ± 0.6 times as much decomposition as electrons. Some differences between the physical properties of electron-irradiated material and the properties of reactor-irradiated material were noted. (auth)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 42884, 43790, 43842, 43843, 43895, 43908, 44067, 44096, 44140, 44337, and 44718.

43686 (AD-645526) POSITIONS FOR 3C REVISED RADIO SOURCES. Fomalont, E. B.; Wyndham, J. D.; Bartlett, J. F. (Owens Valley Radio Observatory, Pasadena, Calif.). 1966. Contract N00014-67-A-0094-0008. 17p. CFSTI.

Positions for 275 radio sources, mainly from the 3C Revised Catalog, were measured with the Owens Valley interferometer as part of a program to identify radio sources with optical objects. The observations were made at a frequency of 1421 MHz. (auth) (TAB)

43687 (AD-645528) A CATALOG OF THE EAST-WEST VISIBILITY FUNCTIONS OF RADIO SOURCES AT 1425 MHz. Vol. 1, No. 3. Fomalont, E. B. (Owens Valley Radio Observatory, Pasadena, Calif.). 1967. Contract N00014-67-A-0094-0008. 73p. CFSTI.

As part of a general program for determining the radio structure of discrete sources, 532 sources were observed using the two 90-foot paraboloids at the Owens Valley Radio Observatory as an east-west interferometer. The frequency of the observations was 1425 MHz and up to nine east-west spacings, ranging from 144 to 2626 wavelengths, were used. (auth) (TAB)

43688 (AD-651480) SIMULTANEOUS OBSERVATIONS OF SOLAR PROTONS INSIDE AND OUTSIDE THE MAGNETOSPHERE. Report No. 67-13. Krimigis, S. M.; Van Allen, J. A.; Armstrong, T. P. (Iowa Univ., Iowa City. Dept. of Physics and Astronomy). Apr. 1967. Contract Nonr-1509. 17p. CFSTI.

Simultaneous observations of low-energy (~0.5-MeV) protons emitted in the solar flare of July 7, 1966, were made with University of Iowa detectors on board the earth satellites Explorer 33 and Injun IV, located outside and inside the Earth's magnetosphere, respectively. It was found that such protons have full and essentially immediate access from interplanetary space to the polar caps of the earth. (auth) (TAB)

43689 (N-67-21457) THE FEBRUARY 5, 1965 SOLAR PROTON EVENT. 1. TIME HISTORY AND SPECTRUMS OBSERVED AT 1100 km. Bostrom, C. O.; Kohl, J. W.; Williams, D. J. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1967. 29p. (NASA-TM-X-55728). CFSTI.

The solar proton event of February 5, 1965 was observed in the polar regions with detectors aboard 1963 38C. The initial detection of protons occurred during the pass at 1914 UT, February 5, and the maximum intensity of 115 cm^{-2} sec^{-1} for $E_p \geq 25$ MeV was seen during the pass at 2103 UT, February 5. The time history of the low energy protons ($E_p \geq 1$ to 2 MeV) was considerably more complex than that of the higher energy particles. The maximum observed intensity ($E_p \geq 2$ MeV) was equal to 775 cm^{-2} sec^{-1} at 0232 UT, February 6 and a second maximum was observed following the onset of the magnetic storm on February 6. The detailed discussion of the low energy proton behavior is taken up in the companion paper. For the higher energies the particle flux decayed approximately exponentially in time with the shorter "lifetimes" associated with the higher energies. An attempt to fit the time history with diffusion theory using a diffusion coefficient of the form $D = Mr^s$ was moderately successful for $E_p \geq 25$ MeV. The spectrum showed a (nearly) monotonic softening with time and a power law generally provided a better approximation to the spectrum than did an exponential form. (auth) (STAR)

43690 (N-67-21459) THE FEBRUARY 5, 1965 SOLAR PROTON EVENT. 2. LOW ENERGY PROTON OBSERVATIONS AND THEIR RELATION TO THE MAGNETOSPHERE. Williams, D. J.; Bostrom, C. O. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Jan. 1967. 31p. (NASA-TM-X-55729). CFSTI.

Observations of the temporal and spatial behavior of low energy (≈1 MeV) solar protons are presented for the solar proton event of February 5, 1965, utilizing data from the near earth satellites 1963 38C and INJUN 4 and spaceprobe Mariner 4. An enhancement of low energy proton intensities is observed at invariant latitudes $\Lambda > 80°$ and may be a low altitude effect of the high latitude topology of the magnetopause. Comparison of the polar cap and Mariner 4 observations indicate that the magnetospheric configuration varies as the boundary conditions imposed by the interplanetary medium vary, thereby causing marked structure in the polar cap proton intensities. Further comparisons of the polar cap and Mariner 4 observations are presented and discussed in terms of (1) a filamentary interplanetary field structure and (2) an extended geomagnetic tail. It is indicated that particle motion across interplanetary field lines near the solar surface or in the region of the shock front is required to explain the low energy proton arrival times in the vicinity of the earth. (auth) (STAR)

43691 (N-67-21772) COSMIC X-RAY SOURCES IN THE 20 TO 180 keV ENERGY RANGE. Brini, D.; Ciriegi, U.; Fuligni, F.; Moretti, E.; Vespignani, G. (Bologna Univ. (Italy). Istituto di Fisica). [1966]. 24p. CFSTI.

Two x-ray sources in the energy range from 20 to 180 keV were detected in two balloon flights. Both fluxes are the same order of magnitude. These could be associated with the two sources already detected at lower energies Serp X1 and Cyg X2. An association of either of them with Cyg X1 is to be excluded, because an upper limit of the flux from Cyg 1 may not be greater than a tenth of that of the other sources. Some energy spectra fitting the data are considered. A power law with an index of about 1.6 appears to give a good fit. The existence of x rays of energy of many tens of keV is indicated, so excluding a black body emission mechanism. (STAR)

43692 (N-67-22873) LUNAR OCCULTATION OF 3C 132. Brown, Larry W. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Apr. 1967. 11p. (NASA-TM-X-55745; X-615-67-165). CFSTI.

The diameter and position of radio source 3C 132 has been determined by means of a lunar occultation. A probable optical identification with a red galaxy has been confirmed. (auth) (STAR)

43693 (N-67-26441) OBSERVATIONS OF THE SOLAR PARTICLE EVENT OF FEBRUARY 5-12, 1965 WITH MARINER IV AND INJUN IV. Krimigis, S. M.; Van Allen, J. A. (State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy). Feb. 1967. 48p. (NASA-CR-84126). CFSTI.

A full time history of the intensities of energetic particles is presented from onset at 1835 ± 10 U.T. on February 5, following a 2^+ solar flare NO8, W25 (which began at 1750 U.T.) until disappearance near the end of February 12. A mixture of low energy protons $E_p > 0.5$ MeV and electrons $E_e > 40$ keV is identified for the first time. Maximum values of proton and electron intensities are presented for the early part of the event. Injun IV data are compared with those of Mariner IV. The time histories of the intensities of both low-energy, $E_p \approx 1$ MeV, and higher-energy, $E_p \approx 55$ MeV, protons over the polar caps of the earth are similar to those at a position 0.15 A.U. from the earth. The propagation of protons with $E_p > 55$ MeV is apparently diffusive. Propagation of the low-energy protons is not consistent with any simple model of interplanetary diffusion. The time profile reveals a spatial structure of $\approx 4 \times 10^5$km. Such particles were distributed over a heliocentric longitudinal range of at least 70° in interplanetary space if the model of solar corotation of a general magnetic field line structure be taken to govern the time history of their intensity. The time history of the intensity of low energy electrons is also presented. (auth) (STAR)

43694 (NASA-SP-153, pp 295-8) MONTE CARLO METHODS IN STELLAR DYNAMICS. Henon, Michel (Centre National de la Recherche Scientifique, Paris (France). Institut d'Astrophysique).

There are two fundamental time scales in a stellar system. The first time scale is associated with collective motions and the second time scale is the "relaxation time" which is associated with the effect of binary interactions. The second phase, or relaxation phase, is studied. It is assumed that collective motions have already died out and that the system is now in a quasi-steady state, changing only under the effect of encounters. The evolution of such a system is studied by Monte Carlo methods. (W.D.M.)

43695 (NASA-SP-153, pp 309-14) RELAXATION OF A TWO-COMPONENT SELF-GRAVITATING GAS. Cohen, Leon (Hunter Coll., New York. Smithsonian Astrophysical Observatory, Cambridge, Mass.); Lecar, Myron (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.).

For self-gravitating systems, the Vlasov equation predicts that the distribution function evolves independent of mass. Hence one can check whether the use of the Vlasov equation is valid by observing certain quantities that would normally be mass dependent. In particular, equipartition of energy among the lighter and heavier masses should not hold. A numerical experiment was performed on the one-dimensional "sheet" model to verify the foregoing. A system of 1000 particles, 500 of unit mass and

500 of mass 10, was integrated for about 20 dynamical periods. (W.D.M.)

43696 (NASA-SP-153, pp 315-21) THE N-BODY GRAVITATIONAL PROBLEM AND THE SIMULATION OF GALACTIC CLUSTERS. Hayli, A. (Centre National de la Recherche Scientifique, Paris (France). Institut d'Astrophysique. Paris Univ. (France). Faculte des Sciences).

Results obtained by different authors in the integration of the N-body problem, both in the absence and in the presence of an external field are reviewed. The problem of simulating galactic clusters is discussed and the equations of motion and the first integrals are given. The principle of a new method for integrating the problem is introduced. Some results are given that were obtained for clusters with 25, 31, 32, and 48 stars with and without a galactic field. (auth)

43697 (NASA-SP-153, pp 323-36) ONE- AND TWO-DIMENSIONAL MODELS TO STUDY THE EVOLUTION OF STELLAR SYSTEMS. Hohl, Frank (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center).

A variational principle has been applied to one-dimensional stellar systems to show that stationary distribution functions which are always decreasing in going outward from the center of the system are stable. Other stationary distributions may be unstable as is illustrated by means of computer experiments. Numerical experiments with a simple two-dimensional rod model show that the spiral structure and other filamentary structure of galaxies may result from purely gravitational effects. It is shown that the minimum energy property which was obtained by Hohl and Feix for a special distribution can be extended to arbitrary distribution functions. (W.D.M.)

43698 (NASA-SP-153, pp 337-47) GRAVITATIONAL EXPERIMENTS WITH A CYLINDRICAL GALAXY. Hockney, R. W. (Stanford Univ., Calif. Inst. for Plasma Research).

A computer model is used to perform gravitational experiments on the evolution of a two-dimensional galaxy. The motion of 2000 rod-stars is computed stepwise in time as they move according to Newton's law of motion in their mutual gravitational field. Phenomena over a time span between 1 and 10 galactic rotations are studied. (W.D.M.)

43699 (NASA-SP-153, pp 349-64) COLLECTIVE MOTIONS IN A SPHERICAL STAR CLUSTER. Henon, Michel (Centre National de la Recherche Scientifique, Paris (France). Institut d'Astrophysique).

The first phase of evolution of a stellar system, i.e., the mixing phase is considered. The associated time scale is the crossing time, which is short compared to the relaxation time, so that the effect of collisions can be neglected. (W.D.M.)

43700 PROPERTIES AND LIMITATIONS OF IMAGE INTENSIFIERS USED IN ASTRONOMY. Livingston, W. C. (Kitt Peak National Observatory, Tucson, Ariz.). Advan. Electron. Electron Phys., 23: 347-84(1967).

A qualitative comparison between the photographic plate and the image tube and a quantitative evaluation of image tubes are presented. Specific types of tubes are described briefly. Advantages and disadvantages and astronomical results obtained with each are listed. Prospects for future development are considered. It is concluded that at present no one type of tube that is best for all purposes exists. (A.G.W.)

43701 VARIABILITY OF ELEMENTARY CHARGE AND QUASISTELLAR OBJECTS. Gamow, G. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 19: 913-14(Oct. 16, 1967).

It is suggested that the absorption spectra of quasars originate neither in their "atmospheres" nor in the intergalactic space, but rather in the individual galaxies through which their light passes. If it is assumed that quasars are located exclusively at very large distances, it can be shown that the probability of their occultation by the galaxies is very high. (W.D.M.)

43702 FIELD STRENGTHS OF 164 kHz RADIO-WAVES RECEIVED AT AHMEDABAD FROM TASHKENT IN 1960–65 AND EFFECT OF SOLAR X-RAY EMISSIONS. Ananthakrishnan, S.; Ramanathan, K. R. (Physical Research Lab., Ahmedabad, India). Proc. Indian Acad. Sci., Sect. A, 66: 60-7(July 1967).

The results of observations on the field strength of 164 kHz radio waves received at Ahmedabad from Tashkent during the period 1960–65 are summarized. There is a general increase in field strength with decrease in solar activity. From the end of 1965 it has been noticed that increases in the intensity of 0 to 8 Å at satellite level are associated with daytime decreases in the field strength of 164 kHz waves received at Ahmedabad. As may be expected, the enhancement of 0 to 8 Å x rays is also associated in a general way with an increased emission from the Sun of 10.7 cm radio waves. Examples are given. (auth)

43703 PRODUCTION OF X-RADIATION IN THE CRAB NEBULA. Apparao, M. V. K. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 66: 55-9(July 1967).

It is suggested that the x rays from the Crab Nebula are due to the synchrotron radiation of electrons of energy $\sim 4 \times 10^{12}$ eV in the magnetic field of the central region of the nebula, the magnetic field being enhanced by hydromagnetic waves. The consistency of the model with experimental x ray observations and the energetics of the Nebula are shown. (auth)

43704 MERCURY: OBSERVATIONS OF THE 3.4-MILLIMETER RADIO EMISSION. Epstein, E. E. (Aerospace Corp., El Segundo, Calif.); Soter, S. L.; Oliver, J. P.; Schorn, R. A.; Wilson, W. J. Science, 157: 1550-2(Sept. 29, 1967).

Observations of the 3.4-mm radio emission from Mercury during 1965 and 1966 yielded the following relationship between average brightness temperature T_B of the disk and the planetocentric phase angle i: $T_B = 277\ (\pm 12) + 97\ (\pm 17) \cos [i + 29\ \text{deg}\ (\pm 10\ \text{deg})]$°K. The errors are statistical standard; the phase shift corresponds to a phase lag—i.e., the maximum and minimum of insolation lag the maximum and minimum of planetary radiation. (auth)

43705 STUDIES IN RADIO SOURCE STRUCTURE. II. THE RELAXATION OF RELATIVISTIC ELECTRON SPECTRA IN SELF-ABSORBED RADIO SOURCES. Rees, M. J. Mon. Notic. Roy. Astron. Soc., 136: 279-91(1967).

A calculation is presented of the synchrotron spectrum of self-absorbed radio sources. It is well known that electron spectra $N(E) \propto E^{-\gamma}$, when γ is a constant $> 1/3$, give rise to radiation spectra whose logarithmic slope is 2.5. It is shown that other forms of N(E) can give rise to radiation spectra either steeper or flatter than this. Such spectra might arise when an initial power law spectrum relaxes. The nature of this relaxation is studied and is shown to depend crucially on whether $\gamma \gtrless 3$. The relevance of these results to observed radio sources is discussed. (auth) (UK)

43706 EVOLUTIONARY SEQUENCE FOR STRONG RADIO SOURCES. Simon, M. (Cornell Univ., N. Y.); Drake, F. D. Nature (London), 215: 1457-59(Sept. 30, 1967).

An attempt is made to show that the results of Heeschen on extragalactic radio sources can be simply interpreted in terms of a consistent evolutionary sequence. It is suggested that only three stages of evolution are required: particle injection into a jet-like structure; adiabatic expansion of a relativistic gas; and, finally, pressure equilibrium with the intergalactic gas. This suggests that the quasars are at cosmological distances. (auth) (UK)

43707 QUASI-STELLAR RADIO SOURCES. Longair, M. S. (Cavendish Lab., Cambridge, Eng.). Contemp. Phys., 8: 357-72(July 1967).

The radio and optical characteristics of quasars are described and contrasted with those of radio galaxies. It is shown how the synchrotron hypothesis of the radio emission from these objects can explain many of the features of their radio spectra. If a consistent model for the evolution of quasars and radio galaxies is sought many difficulties are encountered, particularly during the early stages when the radiation density is very great. The present observational data, however, allow several important conclusions to be drawn about the evolution of quasars and radio galaxies in general. (auth) (UK)

43708 GRAVITATIONAL COLLAPSE OF NEUTRON STARS. Capra, F. (Univ. of Vienna). Nuovo Cim. (10), 51B: 217-20(Sept. 11, 1967).

The question is examined whether a neutron star which has contracted to nuclear density arrives, after further contraction, at a state where the repulsive nuclear forces compensate gravitation or whether the gravitational forces surmount the nuclear hard core and prevent the neutron star from reaching an equilibrium state. Using a plasma approach a result is derived which has been obtained with different methods by several authors: for a collapsing star of sufficiently great mass there is no final equilibrium state. (auth)

43709 ABSORPTION OF X RAYS BY INTERSTELLAR GAS. Bell, K. L.; Kingston, A. E. Mon. Notic. Roy. Astron. Soc., 136: 241-4(1967).

The photo-absorption cross section of soft x rays by interstellar gas is calculated using accurate photo-ionization cross sections, together with the currently accepted composition of the gas. It is shown that the neon K edge is a distinctive feature of this spectrum, even if all the interstellar hydrogen is in molecular form. (auth) (UK)

43710 ROLE OF NEGATIVE IONS IN LATE-TYPE STARS. Vardya, M. S. (Joint Inst. for Lab. Astrophysics, Boulder, Colo. Sterrewacht Sonnenborgh, Utrecht). Mem. Roy. Astron. Soc., 71: 249-69(1967).

The role of twelve negative ions—six atomic, four diatomic, and two triatomic—were investigated. It was found that besides H^-, eight other negative ions—Cl^-, C^-, S^-, OH^-, C_2^-, CN^-, SH^- and H_2O^-—may play significant roles in the outer layers of late-type stars. A better appraisal of the role of negative ions in astrophysics will, however, have to await further laboratory measurements and better high-dipersion stellar spectrophotometry, along with improved theoretical atmospheric models and elemental abundances. (auth)

43711 INTEGRAL EQUATION FOR THE LINE SOURCE FUNCTION AND ITS NUMERICAL SOLUTION. Athay, R. Grant; Skumanich, A. (High Altitude Observatory, Boulder, Colo.). Ann. Astrophys., 30: 669-76(July-Aug. 1967).

A new integral equation is derived relating the source function for a spectral line formed by noncoherent, resonance scattering to the thermodynamic structure of the radiating medium. Numerical solutions are obtained by the introduction of discrete operations, with the resultant set of linear equations solved by matrix inversion. The solutions exhibit a remarkable degree of stability to a reduction in the number of discrete points in optical depth and are particularly well suited for exhibiting the role of the various physical parameters and the detailed character of the source function as it approaches the condition of thermodynamic equilibrium. (auth)

43712 A MODIFIED MILNE–EDDINGTON CURVE OF GROWTH PROCEDURE. Swihart, Thomas L.; Brown, David R. (Univ. of Arizona, Tucson). Ann. Astrophys., 30: 659-67(July-Aug. 1967).

Modifications of the usual Milne–Eddington curve of growth procedure are suggested which increase the realism of the physical situation. They consist of allowing to some extent for the depth dependence of the ratio of line to continuous absorption and of allowing for the differences of conditions under which the lines being analyzed are formed. This permits all lines of an element to be investigated with the same curve of growth, regardless of large differences in the excitation and ionization levels. Numerical examples indicate that the increase in complexity caused by the modifications is worthwhile in those cases for which the above-mentioned effects are important, and the accuracy of the abundance determinations is essentially the same as in the case of a fine analysis. (auth)

43713 FRANCK–CONDON FACTORS OF DIATOMIC MOLECULES. Querci, Monique (Observatoire de Toulouse). Ann. Astrophys., 30: 677-84(July-Aug. 1967). (In French).

The sensitivity of Franck–Condon functions to variations of molecular constants and the expected errors due to these variations of the temperature determination of carbon stars were studied. This work has been carried out using the red system of the radical CN. (auth)

43714 NEW DETERMINATION OF THE PHYSICAL AND CHEMICAL PARAMETERS OF THE ATMOSPHERE OF THE STAR γ SERPENTIS. Spite, Monique (Observatoire de Meudon, France). Ann. Astrophys., 30: 685-96(July–Aug. 1967). (In French).

The study of γ Ser due to Kegel in 1962 was repeated. The method used is that described in a preceding article on χ Draconis. It was found that the general metal abundance ratio is close to $[N_{el}/N_H] = -0.10$. It appears that it is unnecessary to suppose a law of variation of the microturbulent velocity with optical depth different in γ Ser from what it is in the Sun. (auth)

43715 ELEMENTAL ABUNDANCE ANOMALIES IN Ap STARS. Renson, P. (Univ., Liege). Ann. Astrophys., 30: 697-717(July-Aug. 1967). (In French).

From the data in Babcock's catalogue of magnetic stars and the data compiled by Bertaud, the proportion of Ap stars showing striking overabundances of Si, Cr, Mn, Sr, and Eu is deduced in terms of the spectral type. However, this correlation with the spectral class originates at least as much from variations of the visibility of the lines with temperature than from a real dependence of the abundance anomalies on the spectral type. The abundance factors in the Ap stars in regard to the normal ones increase in the average more or less exponentially with the atomic number or the atomic mass. The observed abundances are in disagreement with the explanations proposed by the Burbidges and Fowler for these stars. They appear on the contrary to favor the binary model. (auth)

43716 BRIGHTNESS TEMPERATURE OF THE SKY AT A FREQUENCY $\nu = 178$ MHz. Veron, P. (Observatoire de Meudon, France). Ann. Astrophys., 30: 719-22(July–Aug. 1967). (In French).

The luminosity function for radio galaxies is constructed with 72 galaxies brighter than 18th magnitude, identified in the 3C revised catalogue. The mean emissivity per unit volume due to the radio galaxies is calculated. $I_1 = 15$ to 20 $WHz^{-1}\,st^{-1}/pc^{-3}$ at the frequency $\nu = 178$ MHz. The analogous quantity for normal galaxies is determined thanks to the Heeschen and Wade's catalogue (1964): $I_2 = 27$ to 40 $WHz^{-1}\,st^{-1}/c^{-3}$ at the same frequency. Assuming that the total emissivity $I_1 + I_2$ is uniform in the whole universe; the brightness temperature of the sky due to these objects is calculated: $T_B = 10 \pm 13°K$. This quantity is almost independent of the accelerating parameter q_0. It is very much smaller than the observed brightness temperature at the coldest point of the sky $T_B = 70 \pm 15°K$. A numerical error gave to Zasov (1966) a value of the temperature due to the radio galaxies which is larger than the observed value; his conclusion that we are inside a local concentration of radio galaxies is erroneous. (auth)

43717 A STUDY OF THE CYGNUS LOOP AT 430, 195, AND 41 MHz. Kundu, M. R.; Velusamy, T. (Tata Inst. of Fundamental Research, Bombay). Ann. Astrophys., 30: 723-30(July-Aug. 1967).

Observations of the Cygnus loop, a supernova remnant, on three frequencies 430, 195, and 41 MHz are described. These observations were taken with the 1000-ft-diameter dish of the Arecibo Ionospheric Observatory. There is a broad similarity between the contour maps at the two higher frequencies. However, because of narrower beams, one observes more details and fine structure on the 430-MHz map than on the 195-MHz map. Most of the component sources into which the Cygnus loop is resolved at 430 MHz appear to be nearly coincident with some conspicuous optical features, indicating that a significant fraction of the nonthermal radiation from the supernova remnant is emitted in regions formed by the compression process. Distribution of relative spectral indices were calculated over different parts of the loop. One finds that the spectral index varies from one part to another. The absolute spectrum of one outer region considered to be formed by the compression process appears to be curved and is of the same nature as the spectrum of the general galactic background. This result is consistent with the model of Van der Laan. According to this model the expansion in the interstellar medium of the envelope ejected by a supernova is accompanied by a shock wave propagating ahead of it; as a result a "shell" source is formed outside the ejected envelope. The emission in the shell derives from the interstellar electrons swept up with the galactic magnetic field by the expanding shock wave from the supernova explosion. (auth)

43718 STUDY OF GRAINS OF IRON AND CARBON. Lefevre, J. (Observatoire de Nice). Ann. Astrophys., 30: 731-38(July-Aug. 1967). (In French).

Carbon and iron grains were produced in an argon arc discharge. The grains are associated in chain like structures. Iron grains are cube shaped. Grain size ranges between 200 and 2000 Å. These results show that the development of a theory of light scattering by nonspherical particles is necessary for the study of interstellar absorption. (auth)

43719 VIBRATIONAL STABILITY AND SECULAR EVOLUTION OF HOT DEGENERATE STARS. Baglin, Annie (Institut d'Astrophysique, Paris). Ann. Astrophys., 30: 617-48(July-Aug. 1967). (In French).

The vibrational and secular stability of high central temperature white dwarfs is studied. Different mechanisms leading to energy losses are considered. The neutrino production rate by plasma oscillations is determined using a formula given by Reeves (1965). The energy loss rate from β^- radioactivity reactions is calculated using an approximation to the first order in T for the discrepancy from the Fermi distribution. The influence of partially degenerated outer layers, where Compton scattering is predominant is calculated. These regions are usually more important than the outer envelope studied by Ledoux and Sauvenier Goffrin (1950). The two first mechanisms lead to a very high neutrino luminosity corresponding to a short lifetime. Damping of radial oscillations is larger than the radiative damping considered earlier. So, if the (e,ν_e) (e,ν_e) interaction is real, it plays an important role during the evolution of hot white dwarfs. The main result is that, due to the high damping, destablizing thermonuclear reactions are possible as long as T is larger than 2×10^8 degrees. (auth)

43720 POSSIBLE METHOD FOR INVESTIGATING THE EVOLUTION OF RADIO GALAXIES. Ryle, Martin; Longair, M. S. Mon. Notic. Roy. Astron. Soc., 136: 123-40(1967).

A method is suggested for determining the velocity of ejection

and the ages of the components of double radio sources. The derived variation of the radio luminosity with time suggests that nearly all extragalactic radio sources, including the most compact quasars and the most extensive double radio galaxies, can be accounted for by a single model in which clouds of relativistic particles are ejected from the parent galaxy with an initial velocity close to c. This type of variation of radio luminosity with time may be derived independently from the luminosity distribution of radio galaxies. The cloud velocity and the radio luminosity both decrease to a small value after $\sim 3 \times 10^8$ years. The decrease of luminosity exhibits two main phases and suggests that all classes of powerful sources originate with the release of energetic particles having a total energy of $\sim 10^{62}$ erg, in a galaxy containing a weak magnetic field ($\leq 10^{-5}$ gauss). The expansion from an extremely compact object, exhibiting the effects of low-frequency self-absorption, must be accompanied by amplification of the magnetic field at the expense of the particle energy, and equipartition may be attained after $\sim 2 \times 10^5$ years, when the physical separation of the components is approximately equal to the diameter of the galaxy. The subsequent development, corresponding to the most extensive double sources, involves a rapid decrease of radio luminosity with age as the expansion proceeds without field amplification. (auth) (UK)

43721 TIME-DEPENDENT INTERNAL SOLUTIONS FOR SPHERICALLY SYMMETRICAL BODIES IN GENERAL RELATIVITY. I. ADIABATIC COLLAPSE. Thompson, I. H.; Whitrow, G. J. Mon. Notic. Roy. Astron. Soc., 136: 207-17(1967).

The gravitational collapse of a spherically symmetrical distribution of matter, following an initial nonzero velocity distribution, is investigated on the basis of Einstein's field equations for the adiabatic (radiationless) case with a nonvanishing internal pressure gradient. In particular, it is shown that, if the density is uniform throughout the body at each instant (and so is a function of time only), and if the body continually contracts, it must, as in the pressure-free case, collapse to a point-singularity of infinite density in a finite time, as reckoned by a co-moving observer. To an external observer the body would appear to contract asymptotically to its gravitational radius. The consequences of relaxing the adiabatic condition will be considered in a later paper. (auth) (UK)

43722 LOCAL STRUCTURE OF THE GALACTIC MAGNETIC FIELD. Bingham, R. G.; Shakeshaft, J. R. Mon. Notic. Roy. Astron. Soc., 136: 347-63(1967).

Observations of the polarization and brightness distribution of the galactic nonthermal radio emission are used in conjunction with other evidence to deduce the structure of the interstellar magnetic field within about 1.5 kpc of the Sun. Analysis of the different sources of information and different regions of the sky consistently indicates that the magnetic field is curved and convergent in the region considered, when drawn projected onto the galactic plane. There is also some evidence on the components of the field not parallel to the plane, and the thickness of the magnetic disk is discussed. The magnetic field structure deduced is apparently related to the local stellar spiral arm. (auth) (UK)

43723 THERE IS NO UNIQUE INTERPRETATION FOR THE SOLAR LYMAN α PROFILE. Hearn, A. G. Mon. Notic. Roy. Astron. Soc., 136: 417-24(1967).

Calculations of the profiles of lines emitted by an atmosphere in which the electron temperature, the electron density, and the Doppler width are allowed to vary show that the observed profile of the Lyman α line of hydrogen emitted by the Sun may be produced by atmospheres which have a wide range of Doppler widths. Consequently there is no unique interpretation possible for the Lyman α profile alone. The simultaneous measurement of the Lyman β profile will give additional information, but without further observations and calculations it is not clear if a unique interpretation may be made. (auth) (UK)

43724 RADIAL VELOCITIES OF DISTANT CEPHEIDS AND GALACTIC MODELS. Feast, M. W. Mon. Notic. Roy. Astron. Soc., 136: 141-64(1967).

Radial velocity observations are listed for some distant (r, 2.5 to 4.5 kpc) cepheids near $l^{II} = 290°$. Velocity curves are derived for ten cepheids from 113 spectra (86 Å/mm at Hγ) and less extensive observations are given for eleven other faint cepheids. Standardization is provided by 43 spectra of three bright cepheids. The results are discussed, together with B star and 21-cm observations in the same region. The evidence suggests that there are large scale regional motions (dimension $\approx$1 kpc) as proposed by Weaver (1964). The agreement between the 21-cm observations and the optical results near tangential points appears to be good. This is evidence in favor of the type of galactic model recently proposed by Shane & Bieger-Smith (1966). The best procedure for determining R_0 (the distance to the galactic center) is discussed and a value of 9.8 ± 1.4 kpc is derived. BK Cen and the group of short-period, high-amplitude cepheids are discussed. (auth) (UK)

43725 GALACTIC SPIRAL ARMS AND CENTRAL SPHEROIDAL SYSTEMS. Piddington, J. H. Mon. Notic. Roy. Astron. Soc., 136: 165-83(1967).

An earlier unifying hypothesis of galactic forms [Piddington, J. H. Mon. Not. R. Astr. Soc. 128: 345(1964)] invoked a large-scale magnetic field. When parallel with the rotational axis a featureless disk (SO) developed, and when orthogonal an E or a radio galaxy [Piddington, J. H. Mon. Not. R. Astr. Soc. 130: 125 (1966)]. Here the theory is extended to oblique fields, explaining twin spiral arms, a complex and very active central system and an occasional radio corona. No evolution between galactic forms (say, Sa to SO) is required. The oblique field imposes elliptical gas orbits and develops two regions of maximum field strength outside the galaxy in two opposite sectors which are twisted into two semi-permanent spirals. In one spiral sector the gas in the disk is compressed from above and the formation of stars is accelerated. In the other sector the compression wave enters from below and a particular volume of gas is also compressed once per revolution to form an arm. Inside the disk spirality (nearly circular spirals with varying field directions) may develop and may influence arm structure (knots and branches). The central spheroidal system develops by field winding, as in radio galaxies. Magnetic braking and contraction occur within a region specified by the rotation curve, and here density increases and angular momentum decreases until an axial outburst occurs to form a corona. Rings or closely wrapped arms may be spun off the central system as in our Galaxy. By extrapolating the theory the main features of SO galaxies seem explicable. (auth) (UK)

43726 STATISTICAL DISTRIBUTIONS OF PHOTONS EMITTED BY A STAR. Synge, J. L. Mon. Notic. Roy. Astron. Soc., 136: 195-205(1967).

An investigation was made of the statistical distribution of photons emitted by a star, the world line of a photon being a null geodesic and its four-momentum transported parallelly. The gravitational field of the photons is neglected, so that, although the emission may be time-dependent the gravitational field is statical. Certain results are given for statical fields in general, followed by a specialization to spherical symmetry and finally to the Schwarzschild field. Since no approximations are involved in the general argument, it is applicable in particular to gravitationally intense stars. Except for some initial considerations, the emission is assumed to be symmetric, that is, the same at all points on the star's surface and the same for all directions equally inclined to the surface normal. Under these conditions, Liouville's equation for the distribution function N is solved in terms of an arbitrary function. Related to N, and more relevant to the problem, is the numerical flux density F of photons across any sphere concentric with the star. This is closely connected with N, and its form can be found when its form F_0 for emission across the surface of the star is known. (auth) (UK)

43727 THE RR LYRAE-TYPE STAR HD 176387. Przybylski, A. Mon. Notic. Roy. Astron. Soc., 136: 185-91(1967).

The RR Lyrae-type variable HD 176387 was discovered in a spectroscopic and photometric survey of prospective high-velocity stars. It has a period of 0.316899 days and an amplitude in V of 0.6 magnitude from 8.68 to 9.28. It is the brightest known c-type variable; the rising branch occupies 0.38 of the period. It is a Population-II star with highly inclined and highly eccentric retrograde orbit around the Galaxy. (auth) (UK)

43728 THE SPECTRUM OF THE RADIO BACKGROUND BETWEEN 13 AND 404 MHz. Bridle, A. H. Mon. Notic. Roy. Astron. Soc., 136: 219-40(1967).

Measurements of the brightness temperature of the radio background over a range of declinations at frequencies of 13.15, 17.5, and 81.5 MHz are described. Geometrically scaled aerials having beamwidths of $17° \times 12°$ and $53° \times 12°$ were used, and the results are compared to deduce the spectrum of the background between these frequencies. The observed variation of the spectral index across the sky is fitted by a model in which the galactic contribution has temperature spectral indices 2.38 ± 0.03 and 2.46 ± 0.04 for two different regions of sky, superimposed upon an isotropic background due to radio galaxies, amounting to $30° \pm 7°$K at 178 MHz. The galactic contributions are considered to be associated with radiation from the local spiral arm and from the inter-arm region. The results are compared with those of other workers at 26.3, 38, 81.5, 178, and 404 MHz. In both regions, straight galactic spectra are found between 13.15 and 178 MHz, with temperature spectral indices 2.38 ± 0.02 and

2.45 ± 0.03. Both spectra steepen appreciably by 404 MHz, and it is concluded that the magnetic field strengths are very similar in the two regions. It is suggested that a change in the dominant production mechanism of cosmic-ray electrons takes place at energies in the region of 3 GeV. The observed energy spectrum of primary cosmic-ray electrons is shown to be consistent with that deduced from the new radio data. (auth) (UK)

43729 RADIO SOURCE SPECTRA AND THE COSMOLOGICAL RED SHIFT. Stewart, P. (Univ. of Manchester, Eng.). Nature (London), 215: 1364-5(Sept. 23, 1967).

Recent spectral surveys of discrete radio sources have not revealed any significant dependence of spectral index on apparent density. It was therefore of interest to determine the way in which the mean observed spectral index depends on flux density when the effects of cosmological red shift are taken into account. A hyperbolic world model is taken by way of example. It is intuitively clear that in an expanding Universe only sources with flatter spectra will survive the red shift effect in a given range of flux densities. It has been shown that for a range of feasible model universes uniformly populated with radio sources which have spectra of the form $\nu^{-\alpha}$ observational selection discriminates against high spectral indexes. A spectral survey of discrete sources down to about $S_{178} = 0.1$ (S = observed flux density) may reveal quite significant changes in the average apparent spectral index. The direction of change will depend on the relative effects of spectral curvature, source evolution and distribution, together with geometry. (UK)

43730 ABSORPTION LINE SPECTRUM OF THE QUASI-STELLAR OBJECT 3C 191. Falla, D. F. (University Coll. of Wales, Aberystwyth). Nature (London), 215: 1045-6(Sept. 2, 1967).

It has been stated that in the absorption line spectrum for ions in the gaseous envelope of 3C 191 there is a correlation between the ionization potential and Δz, the difference between z (the red shift of the absorption line spectrum for any ion) and $\bar{z}$em (the mean red shift of the emission line spectrum). A simplified model of a quasi-stellar object is developed in an attempt to explain this correlation. The line spectra are assumed to be produced by electron excitation of gaseous material having a finite velocity of radial flow in the gravitational field of a large central mass. It is proposed that the electrons are emitted from a small source and have a narrow energy spectrum. A correlation between Δz and excitation energy then results if both the electrons and the atoms of the envelope are moving in the gravitational field of the massive object with which the central source of electrons and optical continuum radiation may be associated. Aspects of the system which need to be examined in order that a definite relationship between Δz and excitation energy may be established are discussed. Some difficulties which could affect the validity of the model are also discussed, including the production of electrons with a sufficiently narrow energy spectrum. The decay of $\bar{\Lambda}$ mesons, if of low energy $\ll 5$ MeV, may provide a suitable source. It is concluded that a correlation of the observed form existing between Δz and ionization potential can provide, in terms of the model described, an estimate of recession velocity. In the case of 3C 191 the experimental data are consistent with a Doppler interpretation of the mean emission line red shift. (UK)

43731 PROBABLE VALUES OF THE TIME OF RISE FOR THE FORTHCOMING SUNSPOT CYCLES. Xanthakis, J. (Academy of Athens). Nature (London), 215: 1046-8(Sept. 2, 1967).

The values of the time of rise corresponding to successive sunspot cycles do not appear to show periodicity. If, however, the values for cycles of the same polarity are considered separately, that is, the cycles corresponding to the odd and even values of the current number N, a more or less clear tendency is observed for the minima of the time of rise to recur every eight cycles for cycles with $N = 2K + 1$ and every ten cycles with $N = 2K$, $K = 0, \pm 1, \pm 2, \ldots$. It is shown that each of the two groups $N = 2K + 1$ and $N = 2K$ can be subdivided into two subgroups each of which presents an individual periodic variation. The periods of these variations are very probably multiplets of eight sunspot cycles for $N = 2K + 1$ and ten sunspot cycles for $N = 2K$. Relationships are given to represent satisfactorily existing observational data, together with graphical analyses. The findings are also discussed with regard to relationships between the mean annual values (R_m) of relative sunspot numbers during the year of maximum solar activity, as well as R_{max} and R_{min} of the mean monthly relative sunspot numbers during the same year, and time of rise T_R. (UK)

43732 RELATIVE INTENSITIES OF HYDROGEN RECOMBINATION LINES IN GASEOUS NEBULAE. Dyson, J. E. (Univ. of Wisconsin, Madison). Nature (London), 215: 1365(Sept. 23, 1967).

Measurements have recently been published on the 126α, 159β, and 158β recombination lines of hydrogen in two galactic nebulae. These lines have frequencies differing by <2% and are therefore observed with the same beam width. The results, which assume thermodynamic equilibrium and equal line widths, are summarized. The effect of departures from thermodynamic equilibrium has been pointed out. The present author has calculated values of R for $Te = 10^{4\circ}K$ (R = ratio of line temperature ratio out of thermodynamic equilibrium to that in thermodynamic equilibrium), and curves are shown for R as a function of emission measure for various densities, for Orion and M 17 nebulae. The root mean square electron density of M 17 is 565 cm^{-3} and for the Orion Nebula is $\gtrsim 10^3$ cm^{-3}. R does not depend significantly on density for densities $\gtrsim 10^2$ cm^{-3}. The measured ratios are only in approximate agreement with theory, but definitely show a trend to the occurrence of maser action. There has been no definite detection of broadening in the higher quantum levels. (UK)

43733 HIGHLY IONIZED SPECTRA OF THE TRANSITION ELEMENTS. Fawcett, B. C.; Peacock, N. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Proc. Phys. Soc. (London), 91: 973-5(Aug. 1967).

Spectral lines of Ti VII to XII and isoelectronic transitions of wavelengths between 250 and 600 Å are classified. Identifications of Fe XIV solar lines are confirmed, including the visible coronal line at 5302.86 Å. The ions were excited in a plasma produced by a 500-MW laser beam focused on to metal targets. The target of the pure metal was situated at the Sirks focus of a three-meter, normal-incidence spectrograph. (auth) (UK)

43734 NUCLEAR SPECTROSCOPY AND SOLAR NEUTRINO ASTROPHYSICS. Kocharov, G. E.; Starbunov, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1090-4(July 1966). (In Russian).

Current neutrino astrophysics covers the neutrino astrophysics of the Sun; study of high-energy (≥1 BeV) neutrinos in the atmosphere of the earth and in space; and the neutrino "sea" of the Universe. It is of great interest to examine the problem whether the internal temperature of the Sun changes with time and whether surface phenomena, such as solar flares, are related to events in the inside. The flux and temperature spectrum of solar neutrinos make it possible to cool the internal temperature on the basis of the strong temperature dependence of the neutrino flux with E_{max} = 14.06 MeV (decay of ^{8}B). On the basis of available information, it is concluded that the internal temperature of the Sun may be measured with an error of ≥10%; in order to improve the procession, the various nuclear reaction cross sections must be better known. Study of the interaction of neutrinos with ^{37}Cl is of interest; the β^+ decay of ^{37}Cl and the ^{37}Cl(p,n)^{37}Ar reaction must be studied. Study of the energy of angular distribution of protons in coincidences with positrons and possibly with γ quanta, will eliminate some of the ambiguity in the interpretation of the ground state transition data of ^{36}Ar. Currently, work is in progress in several laboratories on methods to record neutrinos by means of the ^{7}Li(νe^-)^{7}Be; ^{9}Be(νe^-)^{9}B; ^{11}B(νe^-)^{11}C; ^{71}Ga(νe^-)^{71}Ge, etc., reactions; these studies require a more detailed study of the properties of the excited product nuclei of the reactions. (TTT)

43735 POSITION OF "WHISKERS" IN A GROUP OF SUNSPOTS IN RELATION TO THE MAGNETIC FIELD. Koval', A. N. Izv. Krym. Astrofiz. Observ., 34: 278-87(1965). (In Russian).

Ninety-two cases of observations of "whiskers" in a group of sunspots were compared as to their position in relation to the magnetic field, based on detailed visual measurements of the magnetic fields of sunspot groups. The comparison shows that "whiskers" mainly emerge at the boundary of the magnetic field $H_{||} = 0$ polarities and at the edge of the penumbra of large spots in the area of transverse field dissemination. The position of "whiskers" in relation to the magnetic field was studied with maps of longitudinal and transverse fields obtained with the BST magnetograph. The study confirms the conclusion of Severnyy that whiskers appear at points of contact of the crossing or branching out of fields of varying directions. Examination of H_α-films of sunspot groups, in which whiskers were observed, shows that points of whisker appearance are, in most cases, also points of increased flare brightness. The character of the luminescence of the line of metals in the whiskers was examined. This indicates that the whiskers are subjected to a selective excitation mechanism which causes the luminescence of lines with determined excitation potentials of the upper level. The appearance of flares and whiskers in the same points with a specific magnetic field configuration, the analogous character of luminescence of the line of metals in the flares and in the whiskers, and also a series of other factors, indicate the possibility of their having a common nature. (ATD)

43736 ASYMMETRY OF SUNSPOTS. Szymanski, Waclaw. Postepy Astron., 14: 249-55(Oct.-Dec. 1966). (In Polish).

Analysis showing that the observed east–west asymmetry of sunspots is due to the simultaneous action of three factors; the rotation of the sun, the increase in sunspot area, and the sphericity of the sun. (Solar sphericity contributes to the foreshortening of the sunspot area, depending on the position of the spots on the solar disk.) The east–west asymmetry is seen to be a result of purely geometric conditions of sunspot observation. (IAA)

43737 PREFERENTIAL ACCELERATION OF HEAVY NUCLEI ON THE SUN. Kuzhevskii, B. M.; Kurnosova, L. V.; Razorenov, L. A.; Sokolov, V. D.; Suslov, A. A.; Fradkin, M. I.; Shafer, Yu. G. Kosm. Issled. Akad. Nauk SSSR, 5: 306-8 (Mar.-Apr. 1967). (In Russian).

Data on the preferential acceleration of heavy particles on the Sun, which were taken on the Electron-4 satellite are compared with the results of observations on the ionizing ability of the particles, which were carried out on the Cosmos-25 satellite during the same period of time. The data obtained by means of the Cherenkov counter distinguished groups of nuclei with charges $Z > 2$, $Z > 5$ and $Z > 15$ to 20 having energies $E > 600$ MeV/nucleon. An argon-filled ionization chamber was used to measure the total ionization per particle independent of the particle flux. The total ionization per particle increased during certain periods, and could be explained by the passage of heavy particles through the chamber. (TTT)

43738 VIBRATING NEUTRON STARS. Hansen, Carl J. (Yale Univ., New Haven. Goddard Space Flight Center, New York); Tsuruta, Sachiko. Can. J. Phys., 45: 2823-31 (Sept. 1967).

The time variation of some interesting properties of vibrating neutron stars is considered. The models used are based on two nuclear potentials that cover a large spread of possibilities. The modified URCA neutrino process has been assumed to be the major damping mechanism. The calculations are performed both for the case when the vibration energy is partially converted into heat through the URCA process and for the case when this conversion does not take place. It is found that the vibrational energy-storage capacity is extremely model-dependent. The vibrational energies at 1,000 years range from about 10^{47} to 10^{50} ergs, which are sufficiently large as a possible energy source for the x rays from the Crab Nebula. It is shown also that the cooling times of neutron stars will not be significantly increased by the inclusion of the vibrational heating. (auth)

43739 SUPERNOVA HYDRODYNAMICS AND NUCLEOSYNTHESIS. Arnett, W. David (Goddard Space Flight Center, New York); Cameron, A. G. W. Can. J. Phys., 45: 2953-64 (Sept. 1967).

The evolution of matter ejected from the $2M_{\odot}$ core of a collapsing massive star is examined with regard to nucleosynthesis. This material is processed to such extreme conditions of temperature and density that a neutron-rich nucleon gas results. Upon expansion and subsequent cooling it appears that sufficient seed nuclei are formed for neutron capture on a fast time scale (r process) to proceed. Excess neutrons decay late in the expansion, but burn-back to ^{4}He is likely. This results in production of nuclear energy late in the expansion, and can provide sufficient thermal energy to explain the observed light output of supernovae in terms of the increasing transparency of a hot expanding mass of gas. (auth)

43740 ROTATION AND MASSES OF GALAXIES AS DETERMINED BY SINGLE SPACING INTERFEROMETRY OF 21 CM HYDROGEN EMISSION. Rogstad, David Herbert. Pasadena, Calif., California Inst. of Tech., 1967. 123p.

Thesis.

A total of 79 galaxies was investigated with the Owens Valley Observatory's two-element interferometer for content of neutral hydrogen. The baseline used was 100 feet east-west, and the filter bandwidth was 100 kHz. Thirty of the galaxies had detectable emission (>0.5 f.u.). The results are presented as line and position profiles for each galaxy (i.e., plots of the flux, and its position derived from the interferometer phase as a function of radial velocity). An extensive investigation of model profiles is also presented for the purposes of interpretation of the observed results. It is shown that while in most cases the position profile cannot be directly interpreted as the rotation curve, the model analysis does suggest a method for estimating the rotational characteristics of the galaxies from the profiles. Using the estimated rotational parameters, total masses were calculated and are presented along with other quantities derivable from the profiles, such as the galaxy radial velocities and estimates of the neutral hydrogen masses. All of the irregular galaxies that were detected were found to be rotating, with the exception of WLM, which was inconclusive. (Disser. Abstr.)

43741 A HIGH-SENSITIVITY STUDY OF THE GALACTIC NORTH POLAR REGION AT 1415 MHz. Scheer, Donald Jordan. Columbus, Ohio, Ohio State Univ., 1966. 266p.

Thesis.

A continuum survey of the galactic north polar region was conducted at 1415 MHz using the Ohio State University 260-ft radio telescope with a liquid-nitrogen refrigerated parametric preamplifier. The survey covered approximately 975 deg^2 of sky (8100 beam areas) and included most of the area between right ascensions 08^h00^m and 16^h00^m and declinations 25°00′N and 37°40′N. The antenna half power beam widths were 10′ in right ascension and 43′ in declination. The principal endeavors were compilation of the radio source catalog, plotting the segmented contour maps, and determination of results having astronomical significance. Data processing (including contour map plotting) was done on IBM 1620 and 7094 machines. Measured positions and flux densities of 330 discrete ratio sources having flux density $S \geq 0.3$ flux unit (1 flux unit = 1 fu = 10^{-26} watt m^{-2} Hz^{-1}) at 1415 MHz were tabulated. This number of sources gives a sky source density of about 3 deg^2 per source. It is estimated that less than 10% of these sources are galactic, approximately 55% are radio galaxies and about 24% are quasi-stellar radio sources. Positions in both celestial and new galactic coordinates are given. Segmented contour maps having contour interval ΔT_A = 0.025°K were also plotted as a function of 1950.0 celestial coordinates. (TSS) (Disser. Abstr.)

43742 A FINE ANALYSIS OF ALPHA PERSEI AND BETA AQUARII. Parsons, Sidney Bailey. Berkeley, Calif., Univ. of California, 1966. 110p.

Thesis.

The physical conditions in the atmospheres of two yellow supergiants (F5 and G0 Ib) are explored by applying line-blanketed non-gray convective model atmospheres to very high dispersion spectrograms. The models, which include microturbulent pressure in the total pressure, are iterated to nearly constant flux by using the temperature-correction procedure of Mihalas (1965a). The method works well when the convective velocity is evaluated by numerical integration over one mixing length, but tends to be unstable when the usual localized expression is used. Effective temperatures of 6250 ± 150°K and 5650 ± 150°K are indicated for α Per and β Aqr from an analysis of absorption lines of several elements. Profiles of Hγ and Hδ, however, yield values of T_e about 300° higher in both cases. This discrepancy is not considered serious, especially since the computed profiles near the centers of the hydrogen lines are much shallower than the observed profiles. The ionization equilibria for Si, Ti, and Cr yield values of log g = 1.8 ± .5 for α Per and 2.0 ± .5 for β Aqr. Lines of Fe I and Fe II indicate surface gravities larger by a factor of ~10, but this discrepancy may be due to a systematic error in the f values. The value of log g obtained for α Per by neglecting the iron lines is consistent with the absolute magnitude derived from its membership in the α Per cluster. The log g value for β Aqr implies a somewhat lower luminosity than is obtained from the widths of Hα and the K-line emission core. Abundances for most elements agree with the abundances found in the sun. The most notable exception is nitrogen, which is clearly over-abundant in both stars. A nitrogen to carbon ratio of ~5 : 1 is indicated for α Per, while for β Aqr the ratio is on the order of 10 : 1. According to the predictions of Iben (1964), this is evidence that these stars are returning from the red giant phase of evolution. (Disser. Abstr.)

43743 RADIO OBSERVATIONS OF THE SOLAR SUPERCORONA IN 1961, 1962, AND 1963. Gorgolewski, Stanislaw. Torun, Poland, Copernicus Univ., 1964. (In Polish).

Thesis.

Instrumental aspects are dealt with first and data on antenna and receiving systems are presented. The observation material collected contains new data on the amplification of radio emission from the radio source Tau A to 32 MHz. An attempt was made to explain the observed amplification in terms of reflection of radio waves from electron inhomogeneities in the supercorona. Simultaneous three-base observations were done in 1962, which enabled the determination of the directions of ordering of electron inhomogeneities in the supercorona. Interesting data on the shape and spatial orientation of the supercorona in 1962 were obtained on the basis of observation material from Slee. (JPRS)

43744 INTERFEROMETRIC INVESTIGATION OF ACTIVE RADIO CENTERS IN THE SUN. Turlo, Zygmunt. Torun, Poland, Copernicus Univ., 1965. (In Polish).

Thesis.

The thesis deals with investigation of the statistical properties and physical parameters in the disturbed areas of the solar corona (active centers) on the basis of measurement of their radio emission. The observation material was gathered at the Astronomical Observatory of the Copernicus University in Torun in 1963 and 1964 using a twin-antenna interferometer with a base length of 94 λ and a frequency of 127 MHz. (JPRS)

Atomic and Molecular Physics

Refer also to abstracts 43305, 43614, 43711, 43712, 43733, 44202, 44305, 44320, 44331, and 44373.

43745 (D-1-82-0542) ENERGETIC POSITIVE IONS FROM PHOTOIONIZATION OF GASES. Doolittle, P. H.; Schoen, R. I. (Boeing Scientific Research Labs., Seattle, Wash. Geoastrophysics Lab.). June 1967. 42p.

The use of photoionization experiments with ion-retarding potentials is discussed. Preliminary results are presented of measurements obtained with O_2 and N_2O. If O_2 is assumed to dissociate directly, it is estimated that a dissociative state exists which at the equilibrium internuclear separation of the ground state of the neutral molecule lies 20.5 eV above the ground state of the neutral. (auth)

43746 (N-67-18166) NEW INTERPRETATION OF THE $^1\Sigma_u$ AND $^1\Pi_u$ RYDBERG STATES AND VALENCE STATES OF NITROGEN BELOW THE FIRST IONIZATION LIMIT. Dressler, Kurt (Princeton Univ., N. J. Dept. of Astrophysical Sciences). Jan. 1967. 4p. (NASA-CR-81777). CFSTI.

A new interpretation of Rydberg and valence states of nitrogen is presented, which explains previous difficulties of interpretation of experimental data. Configuration interaction accounts for observed complexity. The correlation between the observed (perturbed) levels of nitrogen 14 and the deperturbed vibrational levels of valence and Rydberg states is tabulated. (STAR)

43747 (N-67-20421) THE ENERGY OF INTERACTION BETWEEN TWO HYDROGEN ATOMS BY THE GAUSSIAN-TYPE FUNCTIONS. Hirschfelder, J. O.; Kim, Hojing (Wisconsin Univ., Madison. Theoretical Chemistry Inst.). Feb. 28, 1967. 20p. (NASA-CR-83049; WIS-TCI-222). CFSTI.

The interaction of two hydrogen atoms in their ground states is investigated with a Hirschfelder–Linnett type of wave function in which the exponentials are replaced by Gaussian-type functions. It is found that the long-range interaction is not properly described, but that a reasonable approximation results for the molecular energy near the equilibrium separation. The explicit formulas for the atomic integrals are tabulated. (auth) (STAR)

43748 (N-67-22064) INVESTIGATION OF KILOVOLT ION SPUTTERING. Quarterly Progress Report, November 1966–January 1967. Smith, Harold P. Jr.; Hurlbut, F. C.; Pigford, T. H.; Khan, Jhan; Olson, N. Thomas (California Univ., Berkeley. Space Sciences Lab.). Jan. 31, 1967. Contract NAS3-5743. 10p. (NASA-CR-72013). CFSTI.

Continuing research in the interactions of ions and protons with material surfaces is summarized, including surface-density measurements, velocity-spectrum measurements, mercury-ion sputtering, aluminum–aluminum oxide sputtering, and ion implantation. The proton–surface interactions studies constitute an investigation of the proton-induced characteristic oxygen x rays as a possible surface analysis device for measuring oxygen contamination of material surfaces. (STAR)

43749 (N-67-22076) UNUSUAL RESONANCE LINES OF HIGHLY IONIZED ATOMS OF THE FIRST LONG PERIOD. Feldman, Uri; Cohen, Leonard (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1967. 9p. (NASA-TM-X-55737; X-614-67-112). CFSTI.

Resonance lines originating from energy levels far above the ionization potential have been observed for highly ionized atoms from Ti to Cu. Two of the lines for each ion have been classified as the transitions $2s^2\,2p^6\,3s\ ^2S_{1/2} - 2s^2\,2p^5\,3s^2\ ^2P^0_{3/2,1/2}$ of the Na I isoelectronic sequence. Wavelengths and energy tables are given and a typical spectrogram is presented. (auth) (STAR)

43750 (N-67-22080) NEWLY IDENTIFIED LINES IN Ne I ISOELECTRONIC SEQUENCES. Feldman, U.; Cohen, L. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). Feb. 1967. 9p. (NASA-TM-X-55734; X-614-67-55). CFSTI.

A grazing-incidence spectrometer and a low-inductance, 14 μF, 12- to 17-kV, spark source, were used to observe the spectra of Sc XII, Ti XIII, and V XIV. The lines have been identified as rising from transactions between the ground level $2s^2 2p^6\ ^1S_0$ and the following electronic configurations: $2s\ 2p^6\ 3p$, and $2s^2\ 2p^5\ 4s$, 4d, 5d. The transitions of the type $2s^2\ 2p^6 - 2s^2\ 2p^5\ 4d$ have been observed also in Co XVIII, Ni XIX, and Cu XX. (auth) (STAR)

43751 (N-67-23283) COMPARISON OF GRYZINSKI AND BORN CROSS SECTIONS FOR THE METASTABLE 2s STATE OF ATOMIC HYDROGEN. Monnin, Carl F.; Prok, George M. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Apr. 1967. 34p. (NASA-TN-D-3838). CFSTI.

Excitation and ionization cross sections for electron scattering in metastable atomic hydrogen were calculated by the Born approximation and by the semiclassical theory of Gryzinski. The transitions investigated were excitations from the 2s level to n = 3, 4 and ionization. The energy range of the incident electron was from the threshold to 400 electron volts. In the Gryzinski theory the atomic electrons may be assumed to have a distribution of velocities or a single, average velocity. Excitation cross sections calculated with the use of both assumptions are compared with the results of the Born approximation. The cross section resulting from the velocity distribution agreed better with the Born approximation than with the cross section resulting from the average value of the velocity. Since no experimental results are available, the Born approximation above 200 electron volts is assumed correct. The shapes of the Gryzinski cross section curves are similar to those for the Born approximation over the energy range investigated. (auth) (STAR)

43752 (ORNL–4150, pp 103-12) ATOMIC AND MOLECULAR CROSS SECTIONS. (Oak Ridge National Lab., Tenn.).

Both experimental and theoretical studies have continued to elucidate the formation and properties of the highly excited Rydberg states of isotopic hydrogen molecules. Using computational techniques similar to those used in calculating internal conversion rates in nuclear physics, theory indicates that: (1) HD with its added nonstatic dipole moment decays faster by autoionization than H_2 with only its quadrupole coupling; (2) transition rates of lifetimes for $\Delta l = 2$ transitions are of the order of milliseconds for HD and seconds for H_2; (3) only electronic states for $l = 0$ have lifetimes greater than the particle transit time of 10^{-7} sec; and (4) electronic states for $l > 0$ decay rapidly via $\Delta l = 0$, $\Delta\nu = 1$ transitions. Experimentally, no differences within statistical limitations have been found in the state population of HD and H_2 formed by electron capture collisions in the energy interval 25 to 400 keV. Populations of H^0 and H^0_2 arising from dissociative collisions of H_2^+ and H_3^+, respectively, were a factor of 2 to 4 less than that for the electron capture process. Excited state populations of D^0_2 were approximately 50% greater than for H_2 throughout the energy range. Nonresonant charge-transfer processes have been studied for the argon ions Ar^{3+} to Ar^{5+} in argon and for xenon ions Xe^{3+} to Xe^{6+} in the rare gases neon to xenon. Relative cross sections have been measured for the transfer of 1 to 4 electrons within a scattering angle of $-0.5° \leq \alpha \leq 0.5°$, and in the case of Xe^{n+}–Ar, and Xe^{n+}–Ne collisions absolute cross sections were obtained. All processes exhibit cross sections of the order of 10^{-15} cm^2 for single charge transfer, with double charge transfer 0.4 to 0.9 times as large as single-electron transfer. A notable exception is the collision Xe–Ar where the cross section was found to be consistently greater for the double capture event. Magnitudes and energy dependences of $\sigma_{n,m}$ in the energy range of 0.5 to 1.5 keV times the charge n of the primary ion show an irregular behavior which does not permit extrapolation by simple empirical relationships to higher energies and to collisions involving more highly charged ions. Summaries are presented for the following experiments: K-Auger electrons in argon; $e + H_2^+$ crossed-beam experiment; low-energy electron transfer studies of hydrogen particles in metallic vapors; high-energy charge exchange of H^0 and H^+ in gases; response of silicon surface barrier detectors to heavy ions; and progress of the Atomic and Molecular Processes Information Center. (auth)

43753 (ORNL–4150, pp 113-18) HIGH-CURRENT ION BEAM PRODUCTION AND INJECTION. (Oak Ridge National Lab., Tenn.).

A study is under way to determine the causes of present limitation of beam intensity. A probe has been made which can measure the angular distribution of the rays of intense dc beams as a function of radial position. This device has shown that the effect of space charge produces serious distortion in beams, even under conditions of gross neutralization. In fact, some effects are most severe at high pressure where neutralization is best. Probably radial electric fields in the magnetic lens are responsible. The effect of nonuniformity of curvature of the plasma surface also can be seen. A variety of other experiments have been performed. A new lens coil designed to have a high degree of symmetry and a small stray field gives results comparable to previous lens coils. The small stray field, however, may put it at a disadvantage by reducing magnetic gradients at the ion source. Modifications are being made to permit control of this gradient. An all-copper target cathode was found to give comparable results to the previous source which used a ferromagnetic insert. A four-electrode source and a magnesium vapor cell have been installed on INTEREM, and an equivalent current of 150 mA of 20-keV H^0 has been injected. A reservoir added to increase the volume of the region between intermediate electrode and anode in the DCX-2 source has reduced the turn-on transient to a value of less than 1.3 times the steady cur-

rent and has permitted an increase of injected H_2^+ current into DCX-2 from about 55 mA to about 72 mA. The parts for the non-PIG 600-keV accelerator have been completed, and it is in the final stages of assembly. (auth)

43754 (UCID-15160) EQUATION-OF-STATE CALCULATION THAT INCLUDES SHELL STRUCTURE. Zink, J. W. (California Univ., Livermore. Lawrence Radiation Lab.). June 13, 1967. Contract W-7405-eng-48. 34p. Dep. CFSTI.

The effect of shell structure on equation-of-state calculations is included by requiring the number of free electrons, based on a quantum mechanical calculation, to be consistent with the number of free electrons used to determine an analytic expression for a central potential. The analytic expression for the potential is based upon physical considerations. A code called SHELL is described and comparisons are made between SHELL calculations and Thomas–Fermi calculations as well as Boltzmann–Saha calculations. (auth)

43755 (UCRL-17697) MAGNETIC RESONANCE OF THE IONIC GROUND STATE OF ATOMS THROUGH EXCHANGE COLLISIONS WITH THE METASTABLE STATE; AND INTENSITY BEATS DUE TO COHERENT EXCITATION. Liu, Chung-heng (California Univ., Berkeley. Lawrence Radiation Lab.). July 27, 1967. Contract W-7405-eng-48. 98p. Dep. CFSTI.

Thesis.

Radio-frequency resonances of the metastable state $^3P_2$ of both even and odd isotopes of XeI were observed by monitoring the change of absorption of the $\lambda = 8409$ Å resonance radiation. The metastable state $^3P_2$ of Xe was produced and aligned by the impact of a unidirectional electron beam having high electron-current density and low energy. The high electron-current-density beam has been achieved by using a diode-structure electron gun under the space-charge-neutralization condition. Several values of the g factor of odd isotopes of Xe were measured as $g(J = 2, I = \frac{1}{2}, F = \frac{1}{2}) = -1.2007 \pm 0.0040$, $g(J = 2, I = \frac{3}{2}, F = \frac{3}{2}) = -1.2007 \pm 0.0040$, and $g(J = 2, I = \frac{1}{2}, F = \frac{3}{2}) = -1.7986 \pm 0.0023$. The same experimental arrangement and technique were used to observe spin-exchange-type collisions between the singly ionized ground state $^2P_{\frac{1}{2}}$ of Xe and the metastable state $^3P_2$ of neutral Xe, both being aligned, not oriented by electron impact. Up to the present stage of the experiment, the mechanism of this kind of collision is still not clear; only a phenomenological explanation has been given. Calculation of the signal with the help of the solution of rate equations (in which it has been assumed that the angular momentum changes by only one unit at each collision) showed fair agreement with the experimental results. The value of the g_j factor of the ionic ground state $^2P_{\frac{1}{2}}$ of Xe was measured as $g_j(J = \frac{1}{2}, I = 0) = -1.3344 \pm 0.0003$. Intensity beats were observed in the resonance absorption by the coherently excited nondegenerate magnetic sublevels of the metastable state $^3P_2$ of Hg formed by impact excitation by a high-frequency modulated low-energy, unidirectional electron beam. Since no radio-frequency oscillating magnetic field is needed, this experiment can offer a new method for investigating the excited state of atoms having total angular momentum $J > \frac{1}{2}$. (auth)

43756 BASIC CONCEPTS IN THE SURFACE INTERACTION OF FREE MOLECULAR FLOWS OR MOLECULAR BEAMS. Nocilla, Silvio (Istituto di Meccanica Razionale, Turin). Meccanica, 2: 34-40(Mar. 1967).

A discussion is given of some old and new basic concepts on the surface interaction, in relation to recent developments, in the field of free molecular flows or molecular beams. Topics considered include some concepts of state variables in highly rarefied gases in Maxwellian equilibrium, local and general stagnation temperature, energy accommodation coefficients, free-molecule surface sources, and sinks with application to the author's re-emission model. Comparison with experimental results is made. (BBB)

43757 DENSITY ATTENUATION WITHIN INTERACTING CROSSED BEAMS OF PARTICLES. Rehm, Ronald G. (Cornell Aeronautical Lab., Buffalo). SIAM (Soc. Ind. Appl. Math) Rev., 15: 187-92(Jan. 1967).

The steady-state interaction of crossed beams of particles is considered. When the density attenuation within each beam is comparable with its initial density before interaction (as is the case, for example, of short-duration, (single-pulse), high-intensity crossed molecular beams), a Beer's law approximation to the attenuation is not valid; variations in density across as well as along the direction of each beam must be taken into account. An exact analytical solution to a set of coupled nonlinear partial differential equations describing this process is given for arbitrary boundary conditions. It is assumed that a primary beam (beam 1) of noninteracting particles perpendicularly intersects a secondary beam (beam 2) of noninteracting particles, and that each collision removes both participants from consideration. The equations governing the changes in the number densities $n_1'(x',y')$ and $n_2'(x',y')$ are derived. A plot is diagrammed of the number density $n_1(x,y)$ of the primary beam as a function of the interaction distance x along the beam, for integral values of the distance y along the secondary beam. For $y = 0$, n_1 simply decays exponentially with x (Beer's law); for larger y, n_1 is attenuated much less rapidly as a function of x since the secondary beam has also been reduced by the interaction. A 3-dimensional plot of n_1 as a function of x and y is also shown. For $x = 0$, n_1 is unity, as the boundary condition requires for this example. For fixed $x > 0$, n_1 approaches unity as y approaches infinity; for fixed $y > 0$, n_1 approaches zero exponentially as x approaches infinity. (BBB)

43758 EXPANSION APPROACH TO LOW-ENERGY ELECTRON–HYDROGEN ATOM SCATTERING. Michels, H. H.; Harris, F. E. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev. Lett., 19: 885-6(Oct. 16, 1967).

A new expansion method for calculating scattering phase shifts was described previously (Phys. Rev. Letters, 19:173(1967)) and applied to s-wave scattering by an attractive Yukawa potential. This note reports the first numerical results obtained from this method for electron–atom scattering. The results reported, which give a good definition of scattering from zero energy to the first excitation level, were produced at the total expense of 9 min overall computer time (UNIVAC 1108). More significantly, the procedure is applicable to scattering from much heavier target atoms, those containing as many as 36 electrons. (TSS)

43759 EXCITATION OF 1^1S STATE TO 2^1S STATE OF HELIUM ATOM BY ELECTRON IMPACT IN OCHKUR APPROXIMATION. Banerjee, S. N. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 41: 266-9(Apr. 1967).

The cross section for 1^1S-2^1S transition of the helium atom by electron impact was investigated in Ochkur (1964) approximation near threshold for excitation. The total excitation cross section in the energy range 20.6 eV to 24 eV of incident electron energy has been compared with the most recent experimental findings of Holt and Krotkov (1966). (auth)

43760 DIFFERENTIAL CAPTURE PROBABILITY OF ELECTRON IN PROTON-HYDROGEN COLLISION AT LOW ENERGIES. Chatterjee, Gurudas; Sil, N. C. (Indian Association for the Cultivation of Science, Calcutta). Indian J. Phys., 41: 246-50(Apr. 1967).

Electron capture in proton–hydrogen collision at 3° scattering angle (lab. system) has been investigated, using a two-state approximation. The system of two protons and an electron forms a hydrogen molecular ion, with variable internuclear distance. Only the lowest symmetric and antisymmetric states of H_2^+ are considered and the protons with their associated electron cloud are scattered differently in these two cases. The two different scattering amplitudes are each associated with a time dependent phase which develops differently for the symmetric and antisymmetric states. Finally the amplitudes in different phases interfere and determine the probability of capture. The numerical computation of capture probability shows a very good agreement with experiment regarding the position of maxima and minima, in the energy range 1.1 to 0.45 keV. Below 0.45 keV the present result shows more rapid fluctuations in capture probability which are, however, not found in the experimental curve. (auth)

43761 ON THE PROBLEM OF ELECTRON MOTION IN THE FIELD OF PLANE ELECTROMAGNETIC WAVES. Ternov, I. M.; Khapaev, A. M.; Klimenko, Yu. I. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 35-42(Jan.-Feb. 1967). (In Russian).

Dirac equations for electrons in plane electromagnetic wave fields are resolved as separate equations of electron spin polarization states. The problem of the light scattering Compton effect for moving polarized electrons was resolved as a supplement to the above equations. (tr-auth)

43762 SOURCE OF HIGH-ENERGY NEUTRAL PARTICLES. PART II. Warnecke, R. J.; Vincent, G.; Masic, R. Ann. Radioelec., 22: 157-84(Apr. 1967). (In French).

After setting out the main features of theoretical and experimental work carried out concerning the study of charge exchange which take place as a beam of fast ions passes into a gas target of small thickness, a device for producing neutral particles of high intensity and high energy is described. Developed in 1964, this laboratory device has since received a number of modifications to improve its performance and extend the field of its applications. The results were found sufficiently encouraging to justify the development of a source for industrial production, capable of being used in laboratories concerned with the problem of atomic collisions. Under its designation Eolion, this machine, whose structure is akin to that of a small linear accelerator, is

the outcome of a development to improve the precision and the sensitivity of the method used for measuring the flux of neutral particles, and to improve the technology of this type of source. (auth)

43763 ATOMIC SHIELDING FACTORS FOR NUCLEAR MOMENTS. Wolter, Hermann (Technische Hochschule, Hanover. Univ., Freiburg i. B.). Z. Phys., 205: 492-502(1967).

Atomic shielding factors describe the effect of a deformation of the electron core on the hyperfine structure, which is important for the spectroscopic determination of nuclear moments. For the quadrupole moment they are known as Sternheimer corrections. Such shielding factors for free atoms are discussed in the picture of configuration interaction for the magnetic and electric hyperfine interactions. Calculations were performed with central-field Hartree–Fock functions for B 2p, O $2p^4$, Al 3p, and the levels $3d^5$ 4s $4p^{6,8}P$ of Mn. It was found that even configurations very high in the continuum are admixed by the perturbation, and that all together the contributions from these are much more important than those from bound states. The results are in good agreement with other calculations and they explain experimental data in O and Mn. (auth)

43764 ACCELERATING VOLTAGE AND ELECTRON TEMPERATURE IN A FXR DISCHARGE. Persson, J. E.; Handel, S. K. (Uppsala Univ.). Z. Phys., 206: 266-76(1967).

X-ray quantum energies as well as electron temperatures in different parts of the discharge column in a flash x-ray (FXR) discharge have been estimated. It is found that the energy of the x radiation is about 16 keV very near the cathode surface and about 30 keV at the anode during the first pinching of the discharge column (Initial voltage 20 kV). The electron temperature in the column is found to be 2 to 2.5 keV during the pinch interval, thereafter it rapidly decreases. A dark space is localized to a region just outside the anode surface. This dark region follows the anode when the inter-electrode spacing is varied. (auth)

43765 DEPENDENCE OF THE ENERGY AND INTENSITY OF ω_+ AND ω_- MODES OF THE SURFACE PLASMA OSCILLATIONS IN THIN ALUMINIUM FOILS ON THE ANGLE OF INCIDENCE OF THE ELECTRON. Otto, A.; Swan, J. B. (Univ., Munich). Z. Phys., 206: 277-83(1967). (In German).

Characteristic energy-loss measurements of electrons incident on aluminium foils at angles of 0° and 45° to foil normal show peaks corresponding to the ω_+ and ω_- modes of the surface plasma oscillation. An energy asymmetry about zero scattering angle is observed for the inclined foil, in agreement with the retarded dispersion theory. The intensity ratios of the two modes at different angles of incidence and scattering are in satisfactory qualitative agreement with the theory for oxide coated foils. (auth)

43766 THE CHARACTERISTIC ENERGY LOSSES OF SLOW ELECTRONS REFLECTED FROM ALUMINIUM, GERMANIUM, COPPER, AND GOLD. Thirlwell, J. (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 91: 552-64 (July 1967).

The characteristic energy loss spectra of 200-eV electrons reflected from freshly evaporated Al, Ge, Cu and Au were obtained. The spectra were found to be dependent on the angle through which the primary electrons were scattered. Energy losses which were due to the excitation of volume plasma oscillations were found to decrease in intensity with decreasing scattering angle, while those due to excitation of surface plasma oscillations were found to increase in intensity; thus by obtaining the energy loss spectrum of a given material at two scattering angles (90° and 20° in the experiments described) it is possible to identify those energy losses which result from excitation of plasma oscillations. The plasma losses of Al and Ge were identified in this manner. Copper and gold have more complex spectra than Al and Ge. Only the 3.6-eV energy loss of Cu showed a definite intensity variation with scattering angle, and is interpreted as the surface plasma energy loss. (auth)

43767 MEASUREMENT OF THE LAMB SHIFT $4^2S_{\frac{1}{2}}-4^2P_{\frac{1}{2}}$ OF THE HELIUM ION. Beyer, H.-J.; Kleinpoppen, H. (Univ., Tuebingen, Ger.). Z. Phys., 206: 177-83(1967).

Helium ions were produced in the n = 4 states by electron collisions with ground state atoms, resulting in simultaneous ionization and excitation. Dipole transitions between the Zeeman levels of the states $4^2S_{\frac{1}{2}}$ and $4^2P_{\frac{1}{2}}$ were induced by a microwave electric field. The intensity of the emitted Fowler α line at 4686 Å, corresponding to transitions from the n = 4 to the n = 3 states was then reduced by about 3%. From the measurements, a value of the Lamb shift δ = 1751 ± 25 MHz was obtained, compared with the theoretical value δ = 1768.23 ± 0.55 MHz, and the results of Lea, Leventhal and Lamb of δ = 1765 ± 20 MHz. (auth)

43768 ABSOLUTE MEASUREMENT OF ARGON-II TRANSITION PROBABILITIES. Berg, H. F.; Ervens, W. (RWTH, Aachen). Z. Phys., 206: 184-8(1967). (In German).

Some Ar(II) transition probabilities were measured absolutely using a tungsten ribbon lamp as a calibration standard. The plasma was produced by a conical theta pinch. Gas mixtures of H : Ar and He : Ar were used to exclude inhomogeneity of the layer as a possible source of error. Electron densities and temperatures were determined by measuring hydrogen and helium line profiles respectively, and line to continuum intensity ratios. The measured values can be compared with results of earlier experiments and with newer theoretical calculations. The agreement between the results of this experiment and the theoretical values is satisfactory. (auth)

43769 EMPIRICAL FORMULA FOR THE ELECTRON-IMPACT IONIZATION CROSS SECTION. Lotz, Wolfgang (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 206: 205-11(1967).

An empirical formula with three free parameters is given for the representation of cross sections for single ionization of atoms and ions from the ground state by electron impact. Almost all experimental results can be approximated by this formula within 10% over the whole energy range between threshold and 10 keV; all experimental results can be approximated within experimental error. The formula proposed is not suitable to reproduce the exact contour of fine structures in the ionization cross section curve. (auth)

43770 EFFECT OF PARAMAGNETIC IMPURITY ON THE LONG LIFETIME OF POSITRON IN LIQUID AMMONIA. Majumdar, Chanchal K.; Warke, Chindhu S. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 162: 247-53(Oct. 10, 1967).

The paramagnetic quenching effect of lithium and sodium in liquid ammonia on the long-lifetime component of positron annihilation was computed. The triplet-to-singlet conversion cross sections, calculated in the Born approximation, turn out to be 5.9×10^{-14} cm^2 for Li and 7.2×10^{-14} cm^2 for Na for thermalized positronium. Reasonable agreement with the meager experimental data is obtained. (auth)

43771 MULTIPLE SCATTERING OF HIGH-ENERGY DIRAC PARTICLES. Mukherjee, S. (Indian Inst. of Tech., Kharagpur). Phys. Rev., 162: 254-9(Oct. 10, 1967).

The distribution function for multiple scattering of high-energy Dirac particles has been calculated, starting from an approximate solution of the Dirac equation. With the Thomas–Fermi potential itself, the calculated results are found to be in good agreement with the experimental results. This is in contradiction to the calculations of Nigam, Sundaresan, and Wu, who found it necessary to introduce an arbitrary screening parameter. The multiple scattering of polarized particles is also discussed. (auth)

43772 POSITRON ANNIHILATION IN REAL METALS. II. CALCULATION OF CORE ENHANCEMENT FACTORS. Carbotte, J. P.; Salvadori, A. (McMaster Univ., Hamilton, Ontario, Can.). Phys. Rev., 162: 290-300(Oct. 10, 1967).

A first-principle calculation of core-annihilation enhancement factors in sodium and aluminum is presented. The computations are based on a previously developed theory whose numerical results had formerly been only crudely estimated. The core electrons are treated in the tight-binding approximation using atomic wave functions appropriate to the metallic state. The conduction-band states are taken to be single orthogonalized plane waves. The central core-conduction matrix element of the theory is evaluated with one computational approximation: a simplifying angular average. The enhancement factors obtained have a weak momentum dependence, so the shape of the core contribution calculated without correlations is unaffected. The enhanced contribution of the orthogonalization parts of conduction-electron wave functions remains to be evaluated, so that comparison of our results with experiment is not completely unambiguous. With this reservation, however, the agreement on the whole is satisfactory for both distributions and total lifetimes. (auth)

43773 BACKSCATTERING OF ELECTRONS FROM 3.2 TO 14 MeV. Tabata, Tatsuo (Radiation Center of Osaka Perfecture). Phys. Rev., 162: 336-47(Oct. 10, 1967).

Monoenergetic electrons of energies from 3.2 to 14 MeV provided by a linear accelerator have impinged normally on thick solid targets. Backscattered electrons have been detected by an ionization chamber, the multiplication factor of which was calibrated with a Faraday chamber as a function of average energy per backscattered electron. Angular distributions of backscattered electrons measured for a total of seven targets, effectively semi-infinite and ranging in atomic numbers from 4 to 92, show a trend similar to Dressel's result. However, the backscattering coefficients obtained are lower than his values and are consistent with

those reported by other previous authors. Variations of angular distribution and backscattering coefficient with target thickness also have been investigated for Cu, Ag, and Au targets at an incident energy of 6.1 MeV. Some of the angular distributions observed were compared with results of a simple calculation proposed by the author, and an interpretation has been given that the relative contribution of sidescattering compared with that of diffusion increases with increasing energy in the region considered. Backscattering coefficients for the thinnest targets of lower atomic numbers level off toward a nonzero intercept similar to Cohen and Koral's lower-energy result. This tendency is considered to be caused by the contribution of energetic secondary electrons. The backscattering coefficient $\eta(E_0, Z, \infty)$ of electrons incident on the semi-infinite target of atomic number Z with kinetic energy E_0 above 1 MeV is expressed by an empirical equation $\eta(E_0, Z, \infty) = 1.28 \exp [-11.9\ Z^{-0.65} (1 + 0.103\ Z^{0.37} E_0^{0.65})]$ (E_0 in MeV), appreciable deviations from experimental data occurring only for $Z \leq 6$ and $Z/E_0 \lesssim 2\ \text{MeV}^{-1}$. (auth)

43774 QUENCHING OF TRIPLET POSITRONIUM IN CONDENSED MEDIA. Chandra, G.; Kulkarni, V. G.; Lagu, R. G.; Thosar, B. V. (Tata Inst. of Fundamental Research, Bombay). Phys. Lett., 25A: 368-9(Sept. 11, 1967).

A correlation between the intensity and the lifetime of slow component for positron annihilation in various condensed media is reported. A model for the process is developed, and the results are interpreted on the basis of this model. (auth)

43775 ISOMER SHIFTS IN TRIVALENT COMPOUNDS OF EUROPIUM. Deeney, F. A.; Delaney, J. A.; Ruddy, V. P. (University Coll., Cork, Ireland). Phys. Lett., 25A: 370-1(Sept. 11, 1967).

Measurements of negative isomer shifts in several europium compounds, using the Moessbauer effect in ^{151}Eu, are presented and discussed in terms of partial covalency with the 4f and 5p shells. Back donation is included to explain positive isomer shifts. (auth)

43776 POSITRON ANNIHILATION IN SEMI-CONDUCTING INDIUM TELLURIDE. Murphy, T. A.; Ramaswamy, M. K. (Fordham Univ., Bronx, N. Y.). Phys. Lett., 25A: 379-80 (Sept. 11, 1967).

Angular correlation experiments following positron annihilation in semiconducting indium telluride suggest an effective electron mass $m^* < m$. (auth)

43777 ANOMALOUS MAGNETIC QUENCHING OF THREE-PHOTON ANNIHILATIONS. Florentini, A. (Politecnico, Milan). Phys. Lett., 25A: 401-3(Sept. 11, 1967).

Three-photon annihilation of positrons, slowed down in multicrystalline MgO, shows a magnetic quenching that widely exceeds that of ortho-positronium. (auth)

43778 MOBILITY OF ARGON IONS IN ARGON. Madson, J. M.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Contract AF 19(628)-4794. Phys. Lett., 25A: 407-8(Sept. 11, 1967).

The mobility values of argon ions in argon have been measured using a measuring technique which permits simultaneous measurement of the drift velocity of ions together with their identification by means of a quadrupole mass spectrometer. The three ions present in argon have been identified as Ar^+, Ar_2^+, and Ar^{2+} and their mobilities are consistent with the zero field mobility values of $\mu_0(Ar^+) = 1.54\ \text{cm}^2\ (\text{V-sec})^{-1}$, $\mu_0(Ar_2^+) = 1.83\ \text{cm}^2\ (\text{V-sec})^{-1}$, and $\mu_0(Ar^{2+}) = 2.6\ \text{cm}^2\ (\text{V-sec})^{-1}$ as reported by Beaty. (auth)

43779 FOCUSING OF A THERMAL BEAM OF HYDROGEN ATOMS IN THE FIELD OF A HEXAPOLE MAGNET. Livshits, A. I. Zh. Tekh. Fiz., 37: 906-13(May 1967). (In Russian).

A theoretical discussion is given of the focusing of a beam of neutral hydrogen atoms in the field of a hexapole magnet and formulas are derived for the acceptance angle, the magnification, the distance of the focal point, the density distribution in the focused beam, and the Maxwell broadening of a thermal beam. The theoretical conclusions were verified in an experimental study of the focusing of an atomic hydrogen beam produced in a high frequency discharge at pressures from 0.02 to 0.2 torr, by means of a permanent hexapole magnet consisting of two 5-cm-long sections and producing a field of the order of 5 kOe at the pole pieces. Experimental criteria are given for optimization of the focusing system. It was found that within certain limits the density of the focused beam is independent of the distance from the source to the magnet; this circumstance can be helpful in the design of multiple hexapole magnet systems for producing directed beams of hydrogen atoms. (ATD)

43780 PARABOLIC LENS FOR AXIALLY SYMMETRIC FOCUSING OF RELATIVISTIC PARTICLES. Danilov, L. L.; Rodionov, S. N.; Sil'vestrov, G. I. Zh. Tekh. Fiz., 37: 914-21 (May 1967). (In Russian).

A description is given of the unique wide-angle (0.1 steradian) magnetic lens for focusing relativistic electrons or positrons. A system of two such lenses is used for the conversion of an electron beam into a positron beam with a minimum loss of coherence, which is achieved by locating the target at the common focus of the two lenses. The device operates outside the storage ring into which the positrons are injected. Each lens consists of two metallic paraboloids, electrically joined at the apex and connected at their periphery with a stepdown transformer through concentric tubes. The current flow lines lie in meridian planes and create a tangential magnetic field proportional to 1/r which, combined with a travel distance proportional to r^2 between the paraboloids, gives a deviation proportional to r, i.e., makes linear focusing possible. For aberration-free operation, one of the paraboloids can be replaced by a slightly different surface, the equation for which is derived. Particle scattering is minimized by using a metal of small atomic number (beryllium or aluminum) for the conducting surfaces, and making these as thin as possible (0.25 mm near the apex and 0.15 mm towards the periphery, where the beam is met obliquely). The large forces ($\approx 10^3$ kg/cm^2) arising from the combination of the heavy current ($\approx 10^5$ A) and magnetic field ($\approx 10^5$ gauss) make it necessary to reduce the pulse width to less than 10^{-6} sec in order to avoid deformation or fatigue-cracking. This, however, is much greater than the duration of the electron bunch (2 to 3×10^{-9} sec). Photos show the spot ($\approx$1 mm diameter) into which a 2-cm-wide, 130-MeV electron beam is focused. The transformer, storage capacitor, and triggering thyratron are also described in detail. (ATD)

43781 NUMERICAL DETERMINATION OF THE INTERNAL STRUCTURE OF A HIGH-INTENSITY NONLAMINAR CHARGED-PARTICLE BEAM WITH RIBBON GEOMETRY. Kuznetsov, V. S. Zh. Tekh. Fiz., 37: 932-41(May 1967). (In Russian).

A method is presented for the mathematical determination of current density and particle-velocity distribution in any section of a nonlaminar beam of ribbon geometry, assuming that these elements are known at the origin of the beam. The method is based on a discrete integration of the exact differential equations of the problem, using such a small time variation Δt at each step that the same condition of charge invariance between particle trajectories as prevails in a laminar beam is still approximately satisfied for all particles, despite the possible intersection of their trajectories in the nonlaminar case. The exact equations are then simplified and can be solved numerically. The choice of the interval Δt is discussed in a special section. Application of the theory is made to the case of negligible thermal agitation. The focusing of a charged-particle beam by an ideal lens of f/3.5 aperture is treated as an example. (ATD)

43782 ON THE FOCUSING AND DISPERSION PROPERTIES OF THE FIELD OF A CYLINDRICAL CAPACITOR. Serebryanik, A. N.; Kolker, V. E. (Saratov State Univ., USSR). Zh. Tekh. Fiz., 37: 922-6(May 1967). (In Russian).

An electrostatic field was used between two coaxial cylindrical electrodes for the analysis of a beam of charged particles. In the proposed analyzer the beam enters the field through an opening in the outer electrode, the direction of the beam making a small angle with the axis of the electrodes, and is returned by the action of the field to the outer electrode at a distance that depends on the energy and direction of the particles in the beam. The equations of motion are solved for a charged particle moving in an axial (meridian) plane, and the focusing and dispersion properties of the proposed instrument for meridional trajectories are discussed in detail. The behavior of trajectories not lying in a meridian plane is not discussed. For the proposed instrument there are claimed the advantages of high sensitivity, high resolving power, shielding of the particles in the field of the cylindrical capacitor from the influence of extraneous electric and magnetic fields, and ease of construction. (ATD)

43783 MULTI-CONFIGURATION SELF-CONSISTENT-FIELD THEORY. Hinze, Juergen; Roothaan, Clemens C. J. (Univ. of Chicago). Progr. Theor. Phys. (Kyoto), Suppl., No. 40, 37-51(1967).

A general formalism is presented to solve in a practical way the equations resulting from applying the variation principle to a mixture of configurations constructed from a common orthonormal set of orbitals. The optimization of the configuration mixing coefficients leads to the usual eigenvalue problem and secular equation; the optimization of orbitals leads to self-consistent field equations which strongly resemble the Hartree–Fock equations. Since the mathematical model provides for adjusting the orbitals to a more proper electronic environment as represented by a better total wave function, it is expected that short expansions in

terms of configurations will yield wave functions of high quality. (auth)

43784 EXPERIMENTAL STUDY OF THE EVOLUTION OF THE 6^3P_1 LEVEL OF ^{202}Hg AND ^{199}Hg UNDER THE EFFECTS OF COLLISIONS AGAINST HELIUM ATOMS. Faroux, Jean-Pierre; Brossel, Jean (Faculte des Sciences, Paris. CNRS, Paris). Compt. Rend., Ser. A and B, 264: 1452-3(May 22, 1967). (In French).

Previous measurements of the relaxation time of the 6^3P_1 level of Hg after collision with helium atoms were in disagreement with theoretical predictions and with results obtained with other rare gases. New measurements showed that this disagreement is due to the extinction by an impurity. (tr-auth)

43785 MATHEMATICAL METHODS FOR EVALUATING SECOND-ORDER THREE-BODY INTERACTIONS BETWEEN ATOMS OR IONS WITH GAUSSIAN WAVEFUNCTIONS. Zimering, Shimshon (Battelle Memorial Inst., Geneva). J. Math. Phys. (N. Y.), 8: 1266-70(June 1967).

It is shown that the integrals occurring in the expression for the interaction energy between three atoms or ions in second-order perturbation theory with Gaussian wavefunctions can be reduced to single integrals of three different types. The first two types are erf x and erf ix functions, whereas the third type is a single integral of the error function which is easily evaluated by electronic computation. (auth)

43786 QUANTUM CORRELATION FUNCTION FOR THE NONINTERACTING PARTICLE SYSTEM. Jaen, Jong K. (Univ. of Florida, Gainesville). J. Math. Phys. (N. Y.), 8: 1483-91 (July 1967).

A method for determining the quantum correlation functions of the noninteracting particle system in thermal equilibrium is developed. It is designed to reduce the labor involved in treating the large number of permutation operators of the symmetric group that occurs. An alternate form of the n-particle correlation function is obtained in order to simplify computation. The London–Placzek formula is derived as a check. The error in Kirkwood's superposition approximation for this system is investigated, and the exact relation between the two- and three-particle correlation functions is found. Finally, a method determining the pair correlation function in the Hartree–Fock approximation of a pair-interacting particle system at a finite temperature is presented. (auth)

43787 LIMITING CURRENTS AND ELECTRON–ION OSCILLATIONS IN QUASI-NEUTRAL ELECTRON BEAMS. Nezlin, M. V.; Solntsev, A. M. Zh. Eksp. Teor. Fiz., 53: 437-50(Aug. 1967). (In Russian).

It is demonstrated experimentally that the restriction (cutoff) phenomenon for a current in a quasi-neutral inhomogeneous electron beam moving along an external magnetic field is in accordance with the modern theory of instability of such a beam with respect to buildup of axial nonsymmetric electron–ion oscillations. In the range of the system parameters in which the oscillations are weakly manifest (such as for small beam electron energies in strong magnetic fields), the restriction (cutoff) of the beam current occurs later and is defined by the well-known Pierce instability. (auth)

43788 SEARCH FOR ATOMIC MUONIUM IN CHEMICALLY INERT SUBSTANCES. Myasishcheva, G. G.; Roganov, V. S.; Obukhov, Yu. V.; Firsov, V. G. (Inst. of Theoretical and Experimental Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 451-8 (Aug. 1967). (In Russian).

The behavior of triplet muonium in a number of substances under temperature and other conditions is investigated by observing the precession in a transverse magnetic field. The presence of atomic muonium in crystal and fused quartz, in solid carbon dioxide, and in ice is demonstrated. The results are discussed from the viewpoint of physico–chemical interactions of muonium. (auth)

43789 CONVERSION OF POSITRONIUM ATOMS ON O_2 AND NO MOLECULES. Mokrushin, A. D.; Goldanskii, V. I. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 478-83(Aug. 1967). (In Russian).

Angular correlation curves for annihilation γ quanta are measured in a number of pure gases and in Ar + O_2 and Ar + NO gas mixtures at pressures of the order of 100 atm. A method for separating the narrow component in the experimental curves is presented for monoatomic and polyatomic gases. The cross section for conversion of positronium atoms on O_2 and NO molecules are obtained from an analysis of the curves for the gas mixtures. The cross sections for formation of positronium atoms on the same molecules are also estimated. (auth)

43790 INNER-SHELL TRANSITIONS IN Ca XII, XIII, XIV, AND IN ISOELECTRONIC IONS OF K, Sc, AND Ti IN LASER-PRODUCED PLASMAS. Fawcett, B. C.; Burgess, D. D.; Peacock, N. J. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Proc. Phys. Soc. (London), 91: 970-2(Aug. 1967).

Plasmas generated by focusing Q-spoiled ruby lasers onto solid targets are used as spectroscopic sources for the study of far vacuum ultraviolet emission spectra of ions of astrophysical interest. New, inner-shell transitions of fluorine-, oxygen-, and nitrogen-like ions are classified in S X, K XI, XII, XIII, Ca XII, XIII, XIV, Sc XIII and Ti XIV. Other new classifications in Cl XII to XIV are also listed. (auth) (UK)

43791 CALCULATION OF THE RATE OF ATOMIC REACTIONS AT LOW ENERGIES. Bykhovskii, V. K. (Inst. of Chemical Physics, Moscow). Teor. Eksp. Khim., 3: 191-5(Mar.-Apr. 1967). (In Russian).

The Schroedinger equation matrix (in electron channel space) for for wave functions of the relative nuclear motion was used in order to obtain a corresponding quasi-classical equation. With an additional limitation, the matrix quasi-classical equation is converted into the basic equation of the impact parameter, the reaction rates being programmed by Algol-60. (R.V.J.)

43792 THE THEORY OF DIRECT ATOMIC–MOLECULAR REACTIONS. I. Ivanov, G. K.; Sayasov, Yu. S. (Inst. of Chemical Physics, Moscow). Teor. Eksp. Khim., 3: 172-84 (Mar.-Apr. 1967). (In Russian).

A systematic theory of atomic (or ionic)–molecular reactions during the direct interactions between incident particles and bound atoms in molecules was developed. The analysis was limited to phenomena taking place in a system of a certain number of particles related to the potential, which depended on the distances between particles, and it was assumed that the interactions of each incoming particle with each atom in the molecule were of the pulsed type. Thus, cross sections of various chemical transformations were calculated using the modified pulse approximation. Simple formulas were obtained for the cross sections of chemical transformation of A + BC = AB + C (where AB is a diatomic molecule or ion and A is the atom or ion) type which is produced by direct knocking out of the atom C. It was also shown that the even at high energies the examined processes did not perform according to classical concepts (as was assumed in Libby's billiard ball model) but were determined by overlapping of the wave functions of the BC and AB molecules. The general theory was applied in the series of specific ion–molecule reactions: $Ar^+ + D_2 \rightarrow ArD^+ + D$, $Ar + D_2^+ \rightarrow ArD^+ + D$, $Ar + HD^+ \rightarrow ArD^+ + H$, $Ar + HD^+ \rightarrow ArH^+ + D$. The theoretical and experimental data were found to be in good agreement. (R.V.J.)

43793 DENSITY EFFECT IN THE BREMSSTRAHLUNG OF 600-MeV ELECTRONS. Arutyuonyan, F. R.; Ispiryan, K. A.; Oganesyan, A. G.; Frangyan, A. A. (Joint Radiation Laboratory, Erevan. Erevan State Univ.). Dokl. Akad. Nauk Arm. SSR, 44: 65-9(1967). (In Russian).

Bremsstrahlung spectra from 600-MeV electrons in Duralumin and organic glass at energies up to 100 keV were studied in order to determine the influence of the medium density on the bremsstrahlung. Bremsstrahlung from relativistic electrons were also investigated. The experiment was carried out in a 680-MeV synchrotron, with electrons recorded by a telescope consisting of two thin plastic scintillators followed by magnetic field deflection. Gamma quanta were recorded by a single-crystal (NaI(Tl), ϕ7 cm, and h = 7 cm) γ spectrometer in the direction of the initial electron motion. The obtained experimental spectra and the theoretical curves of the bremsstrahlung of an isolated atom, considering the effect of density, are included. Results indicate the influence of the dielectric properties of the media, but the effects of density were not observed. (R.V.J.)

43794 COLLISIONAL IONIZATION OF LONG-LIVED HIGHLY EXCITED ATOMS. Hotop, H.; Niehaus, A. (Univ., Freiburg, i. B.). J. Chem. Phys., 47: 2506-7(Oct. 1, 1967).

In a study of the collision of highly excited atoms (X^{**}) with certain ground-state molecules (M), the following reaction was found to take place: $X^{**} + M \rightarrow X^+ + (M + e^-)$. The experimental arrangement used and the method of determination of the absolute cross sections for the reaction from the pressure dependence of X^+ are described briefly. Cross sections are tabulated for reactions of He, Ne, and Ar with H_2O, NH_3, SO_2, C_2H_5OH, and SF_6. The cross section for the reaction $Ar^{**} + SF_6 \rightarrow Ar^+ + SF_6^-$ derived from the pressure dependence of SF_6^- is also given. (A.G.W.)

43795 STUDY OF COLLISION-INDUCED PHENOMENA WITH A DEMPSTER MASS SPECTROMETER. I. THEORETICAL. Harris, Harold H. (Michigan State Univ., East Lansing); Russell, M. E. J. Chem. Phys., 47: 2267-9(Oct. 1, 1967).

The natural focusing characteristics of the Dempster mass spectrometer are used to derive equations for the measurement of cross sections for collision-induced reactions and for total collision cross sections. (auth)

43796 STUDY OF COLLISION-INDUCED PHENOMENA WITH A DEMPSTER MASS SPECTROMETER. II. EXPERIMENTAL. Harris, Harold H. (Michigan State Univ., East Lansing); Russell, M. E. J. Chem. Phys., 47: 2270-5(Oct. 1, 1967).

A method for the study of collision-induced phenomena in a Dempster mass spectrometer is demonstrated. Experimental studies are made of the following reactions, and their reaction cross sections are determined at 1000 V ion-accelerating potential: $Ar^{2+} + Ar \rightarrow Ar^{+} + Ar^{+}$, $\sigma = 3.6 \times 10^{-16}cm^2$; $CO^{+} + CO_2 \rightarrow C^{+} + O + CO_2$, $\sigma = 6.6 \times 10^{-17}cm^2$; $N_2^{+} + N_2 \rightarrow N^{+} + N + N_2$, $\sigma = 3.5 \times 10^{-17}cm^2$; $N_2O^{+} + N_2O \rightarrow NO^{+} + N + N_2O$, $\sigma = 6.3 \times 10^{-17}cm^2$; $CO^{2+} + CO \rightarrow C^{+} + (O^{+}) + (CO^{+})$, $\sigma = 1.4 \times 10^{-17}cm^2$. The value of $1.0 \times 10^{-17}cm^2$ for the reaction $CO^{+} + CO \rightarrow C^{+} + O + CO$ was used for calibration. In addition, the total collision cross sections for the following systems were determined: CO^{+} in CO, $\sigma_T = 2.4 \times 10^{-16}cm^2$; O^{+} in CO, $\sigma_T = 5.0 \times 10^{-17}cm^2$; C^{+} in CO, $\sigma_T = 1.8 \times 10^{-16}cm^2$; Ar^{+} in Ar, $\sigma_T = 2.2 \times 10^{-15}cm^2$; Ar^{2+} in Ar, $\sigma_T = 1.2 \times 10^{-15}cm^2$. (auth)

43797 IMPROVEMENT OF UNCOUPLED HARTREE-FOCK EXPECTATION VALUES FOR PHYSICAL PROPERTIES. II. Epstein, S. T.; Johnson, R. E. (Univ. of Wisconsin, Madison). J. Chem. Phys., 47: 2275-7(Oct. 1, 1967).

A comparison is made between approximate polarizabilities calculated in the coupled Hartree–Fock approximation with those obtained from the uncoupled Hartree–Fock approximation with first-order corrections. (auth)

43798 EVALUATION OF ORBIT–ORBIT INTERACTION IN MANY-ELECTRON ATOMS. Malli, Gulzari (Univ. of British Columbia, Vancouver). J. Chem. Phys., 47: 2217-19(Oct. 1, 1967).

Orbit–orbit interaction has been evaluated for all the neutral atoms (in their ground states) up to radon (Z = 86) using the numerical Hartree–Fock wavefunctions of Froese. Agreement between previous calculations and that reported here is excellent wherever earlier results are available. (auth)

43799 EQUIVALENCE OF THE RUBINOW AND SECOND HULTHEN VARIATION METHODS. Williams, K. L. (University Coll., Cardiff, Wales). Proc. Phys. Soc. (London), 91: 807-9(Aug. 1967).

It is shown that Rubinow's method is a reformulation of the second Hulthén method. The two methods give the same results. (auth) (UK)

43800 CHARGE-CHANGING COLLISIONS INVOLVING FAST HELIUM BEAMS: THE EFFECT OF A METASTABLE ATOM COMPONENT. Wittkower, A. B.; Levy, G.; Gilbody, H. B. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 91: 862-7(Aug. 1967).

Cross sections σ_{10} and σ_{01} for one-electron capture and loss were determined in the energy range 60 to 400 keV by studying, respectively, the charge neutralization and stripping of helium ion and atom beams during passage through "thin" targets of hydrogen and helium. In the studies of electron loss, measurements made with helium atom beams prepared by charge-transfer neutralization of He^{+} ions during passage through various "thick" gaseous targets were found to yield apparent cross sections σ_{01} which were dependent on the particular neutralizer gas. For example, in the energy range investigated, values of σ_{01} for helium atoms in hydrogen were found to increase by between 18% and 40% when hydrogen was substituted for helium as the neutralizer gas, an effect believed to be due to the formation of an increased fraction of metastable helium atoms in the fast beam. The apparently strong influence of a helium metastable atom component in this case suggests that a satisfactory description of the charge equilibration of fast helium beams during passage through thick gaseous targets cannot always be given in terms of a simple three-component system. Previous data on electron capture and loss obtained by the use of such a treatment must therefore be interpreted with extreme care. (auth) (UK)

43801 ELECTRON DETACHMENT IN OXYGEN. Eccles, M. J.; Craggs, J. D. (Univ. of Liverpool). Electron. Lett., 3: 146-7(Apr. 1967).

A new experimental method for determining electron detachment (δ) coefficients in swarm conditions in gases is described. Data are given for oxygen at pressures of 20 and 40 torr (E/p = 40 to 50 V cm^{-1} $torr^{-1}$). δ/p varies from 2×10^{-3} to about $1.3 \times 10^{-2}cm^{-1}$ $torr^{-1}$. (auth) (UK)

43802 STUDIES ON THE SPECTRAL LINE SHAPE. II. SELF ABSORPTION. Tako, Toshiharu (National Research Lab. of Metrology, Tokyo). Keiryo Kenkyu-Sho Hokoku, 16: 107-26 (July 1967). (In Japanese).

The line shape, width, and other properties of self-absorbed line are discussed by introducing several models on the spatial distributions of the emitting and absorbing atoms. It is proved that the simple models in which the emitting atoms decrease linearly from the center to the outside are satisfactory to support the general views on the self-absorption. The shapes of the visible triplet lines emitted by ^{198}Hg and ^{114}Cd lamps are observed without being disturbed by hyperfine structure of isotopes using a direct recording F–P interferometer. From these observations the effect of self-absorption of these lines is made clear and is shown to agree well with the results theoretically obtained. Moreover it is found that ^{198}Hg and ^{114}Cd lamps can be approximately represented by the model in which the emitting atoms decrease linearly from the maximum at the center to zero at the wall. The values of absorption parameter evaluated can be explained without inconsistency, taking the population and decay time of the triplet states and their quenching due to collisions with carrier gas and electrons into consideration. (auth) (NSA of Japan)

43803 PIONIC 2p–1s TRANSITIONS. Backenstoss, G.; Charalambus, S.; Daniel, H.; Koch, H.; Poelz, G.; Schmitt, H.; Tauscher, L. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg. Technische Hochschule, Karlsruhe, Ger.). Phys. Lett., 25B: 365-8(Sept. 18, 1967).

Pionic 2p-1s transitions from Be, ^{10}B, C, N, ^{16}O, ^{18}O, F, and Na have been measured with the Ge counters. Data for 1s level shifts and widths are given. No lines were found for Mg and Al. (auth)

43804 INFLUENCE OF THE MASS ON THE BOUND STATES OF MOLECULAR SYSTEMS. Joseph, A. (Mathematical Inst., Oxford). Proc. Phys. Soc. (London), 91: 574-6(Aug. 1967).

The general dependence of the energy levels belonging to the discrete spectrum of a multiparticle Hamiltonian on the particle mass is derived. The implications of this result in molecular systems are discussed. (auth) (UK)

43805 MEASUREMENT OF THE CROSS SECTION FOR IONIZATION OF Li^{+} TO Li^{2+} BY ELECTRON IMPACT. Wareing, J. B.; Dolder, K. T. (Univ. of Newcastle-upon-Tyne, Eng.). Proc. Phys. Soc. (London), 91: 887-93(Aug. 1967).

A new apparatus, based on the crossed-beam principle, was used to measure the cross section of Li^{+} in the reaction $Li^{+} + e \rightarrow Li^{2+} + 2e$ for electron energies up to 1000 eV. The cross section reaches a maximum value 4.0×10^{-18} cm^2 for electrons of 350 eV energy. The maximum total errors of the measurements are assessed to be ±25% near threshold and ±10% at higher electron energies. Within these limits the results agree with the measurements on Li^{+} by Lineberger, Hooper, and McDaniel in 1966. The present measurements also agree very closely with cross sections for the ionization of neutral helium measured by Smith in 1930 when the latter are multiplied by the classical scaling factor $(X_2/X_1)^2$, X_1 and X_2 being the ionization energies of Li^{+} and He, respectively. (auth) (UK)

43806 SOME CALCULATIONS ON p–H CHARGE TRANSFER. Morrison, D. J. T.; Rudge, M. R. H. Proc. Phys. Soc. (London), 91: 881-6(Aug. 1967).

A simple technique previously used by the authors in electron–atom scattering is modified to describe a charge-transfer process and calculations are performed for the case of protons colliding with atomic hydrogen. A comparison with experimental and other theoretical results is made. It is found that the method is less successful in describing charge-transfer processes than in describing exchange processes in electron–atom collisions. (auth) (UK)

43807 ASYMPTOTIC FORM OF THE ELECTRON CAPTURE CROSS SECTION IN THE SECOND BORN APPROXIMATION. Mapleton, R. A. (Cambridge Research Labs., Bedford, Mass.). Proc. Phys. Soc. (London), 91: 868-80(Aug. 1967).

The asymptotic variation of the amplitudes at high impact energies for the non-resonant $H^{+} + D(1s) \rightarrow H(1s) + D^{+}$ and symmetrically resonant $H^{+} + H(1s) \rightarrow H(1s) + H^{+}$ process are calculated approximately in the second Born approximation using the final-state Green function G_f. Although agreement with the results of Drisko is obtained for scattering at small angles by approximating the Coulomb functions of G_f by plane waves, this agreement may be fortuitous for two reasons: (i) an exact calculation might yield ambiguous answers; (ii) sums of contributions from an infinite number of discrete intermediate states, each varying with the same power of impact energy, may not be finite. In the case of symmetrical resonance not only do contributions also originate from the angular region near $\theta = \pi$, but all but one of these cal-

culated partial amplitudes is dominated by the corresponding first Born amplitude; the same calculational difficulties, (i) and (ii), also occur for this case. Contributions from the 1s intermediate state diverge for each part of the post interaction V_f, but these divergences cancel when the complete interaction V_f is used. (auth) (UK)

43808 Z^{-1} EXPANSION OF THE UNRESTRICTED HARTREE–FOCK EQUATIONS FOR THE $(1s)(1s')$ ^1S STATE OF HELIUM AND HELIUM-LIKE IONS. II. Hibbert, A. (Oxford Univ., Eng.). Proc. Phys. Soc. (London), 91: 819-24(Aug. 1967).

It is shown that the unrestricted Hartree–Fock equations may be solved by expanding the orbital wave functions in perturbation series with parameter Z^{-1}. The work of a previous paper is extended to the calculation of the orbital functions to second order, and the energy to fifth order. A similar calculation is made for the restricted Hartree–Fock approximation. The higher-order energy coefficients are estimated. Using these estimates, the restricted Hartree–Fock energy sums to −2.861 68 a.u., which is the value obtained by Roothaan et al., while the unrestricted Hartree–Fock energy sums to −2.877 99 a. u., which is the value obtained by Froese. [Phys. Rev., 150: A1-6(1966)]. (auth) (UK)

43809 TWO-QUANTUM PROCESSES IN THE COUPLED HARTREE–FOCK APPROXIMATION. Victor, G. A. (Queen's Univ. of Belfast). Proc. Phys. Soc. (London), 91: 825-9(Aug. 1967).

A method, based upon time-dependent Hartree–Fock theory, is developed for calculating the efficiencies of two-photon processes. The lifetime for two-photon decay of $He(2\ ^1S)$ is calculated with the result 2.0×10^{-2} sec. Estimates for the cross section for the two-photon ionization of the ground state of helium are given for photon energies near the two-photon threshold. For incident photons at a wavelength of 1000 Å the cross section is $5 \times 10^{-34} I\ cm^4\ w^{-1}$, where $I(w\ cm^{-2})$ is the intensity of the incident photons. (auth) (UK)

43810 STARK STATES AND O(4) SYMMETRY OF HYDROGENIC ATOMS. Hughes, J. W. B. (Queen Mary Coll., London). Proc. Phys. Soc. (London), 91: 810-18(Aug. 1967).

The O(4) symmetry of hydrogenic atoms is used to interpret angular momentum $|nlm\rangle$ and Stark $|n_1n_2m\rangle$ eigenstates as different realizations of irreducible representations of the O(4) group. Differential expressions are obtained for $|n_1n_2m\rangle$ shift operators, and for the $|nlm\rangle$ shift operator O_{-}^{1} which changes l and m by −1. These are used to obtain the formula for the transformation matrix elements connecting the two sets of states. (auth) (UK)

43811 VAINSHTEIN APPROXIMATION FOR ELECTRON–ATOM COLLISIONS. Crothers, D. S. F. (Queen's Univ. of Belfast). Proc. Phys. Soc. (London), 91: 855-61(Aug. 1967).

The Vainshtein approximation for electron–atom collision may be based on either the post or the prior wave function. Both versions involve a supplementary peaking approximation. In using the prior function Vainshtein and his colleagues introduced an arbitrary modification of the peaking approximation. The removal of this modification alters the cross section considerably. In the case of atomic hydrogen it leads to cross sections for 1s–2s and 1s–2p excitation and for ionization which are markedly different from those based on the post function. For a real effective charge the prior function gives a low-energy maximum which exceeds that of the first Born approximation, which in turn exceeds that of the post function. No sharp peak appears near to threshold. The accuracy of the Vainshtein approximation remains an open question. It is tentatively suggested that the post function might with advantage be used for inelastic collisions and the prior for superelastic collisions. (auth) (UK)

43812 GAS INCORPORATION INTO SPUTTERED FILMS. Winters, Harold F.; Kay, Eric (International Business Machines Corp., San Jose, Calif.). J. Appl. Phys., 38: 3928-34(Sept. 1967).

The concentration of argon in sputtered nickel films has been obtained as a function of the film-growth temperature, the discharge pressure, and of the energy (bias voltage) with which the argon ions bombard the growing film. The concentrations vary from about 10^{-1} argon atoms/Ni atom to 10^{-4} argon atoms/Ni atom, depending upon the conditions during film growth. The incorporation of both argon and nitrogen into nickel films is interpreted on the basis of results previously obtained from sorption studies in a more-idealized system on a pre-existing nickel surface. (auth)

43813 INCOHERENT SCATTERING OF GAMMA RAYS IN URANIUM. Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Appl. Phys., 38: 3927-8(Sept. 1967).

The effect of electron binding on the incoherent scattering of gamma rays in uranium in the energy region 320 to 1332 keV is studied using the total cross sections of Colgate [Phys. Rev., 87: 593(1952)] and Wyard [Phys. Rev., 87: 165(1952)]; total photoelectric cross sections of Rakavy and Ron [Phys. Letters, 19: 207(1965)]; and coherent-scattering cross sections based on Thomas-Fermi calculations [W. Brown, Boeing Co. Report D2-125137-1 (Dec. 1966)]. Combining these data, it is concluded that the effect of electron binding on the incoherent-scattering cross section for uranium in the region 320 to 662 keV exceeds that predicted by the Thomas–Fermi model. (auth)

43814 COMA-DOMINATED ABERRATION IN MAGNETICALLY DEFLECTED ELECTRON BEAMS. Wang, C. C. T. (International Business Machines Corp., Yorktown Heights, N. Y.). J. Appl. Phys., 38: 3991-4(Sept. 1967).

The aberration of coma, occurring in a magnetically deflected electron beam, has been studied. Shapes of the deflected spot and equal-density contours within it have been calculated for the cases where the density distribution across the beam before deflection is assumed to be either uniform or Gaussian. When coma is close to its minimum, the shape of the spot assumes a fan shape. (auth)

43815 EXTRACTION OF DENSE ION BEAMS FROM PLASMAS. Kramer, N. B.; King, H. J. (Hughes Research Labs., Malibu, Calif.). J. Appl. Phys., 38: 4019-23(Sept. 1967).

An ion optical system suitable for extracting dense ion beams from gas discharges is described. A study of the beam forming characteristics of the system was performed by using an automatic trajectory tracer with space-charge simulation. Experimental measurements show that the extraction system operates satisfactorily over a wide range of current densities; total mercury-ion beam currents in excess of 1 A have been achieved. An empirical method of estimating perveance as a function of geometry, based on electrolytic tank measurements, is in agreement with experimental results. (auth)

43816 ELASTIC SCATTERING FROM ATOMIC OXYGEN AND PHOTODETACHMENT FROM O. Henry, Ronald J. (Kitt Peak National Observatory, Tucson, Ariz.). Phys. Rev., 162: 56-63(Oct. 5, 1967).

A method developed by Temkin to allow for polarization effects in low-energy scattering of electrons from atoms has been extended to include all direct contributions from the polarized orbitals and the exchange contribution from the most important type of polarized orbital. The analysis has been applied to atoms with configurations $1s^22s^22p^6$. Cross sections for the elastic scattering of slow electrons by atomic oxygen are given for energies <6.5 eV. The additional direct polarization terms are found to be important in calculating s-wave elastic cross sections for O, as they decrease the cross section by a factor of 2 near threshold; but the exchange d orbitals of the oxygen atom are relatively unimportant in relation to all direct polarization terms. Photodetachment cross sections for O^- are given for photon energies in the range 1.47 to 5.5 eV, and are found to be in good agreement with experiment when polarization terms are included and the dipole velocity approximation is used. (auth)

43817 SCHROEDINGER PERTURBATION FORMALISM FOR EXCHANGE INTERACTIONS BETWEEN ATOMS OR MOLECULES. Jansen, Laurens (Battelle Inst., Geneva). Phys. Rev., 162: 63-8(Oct. 5, 1967).

A Schrödinger perturbation expansion is developed for exchange interactions between atoms or molecules, starting from a complete, orthonormal set of symmetrized basis functions. The unperturbed Hamiltonian H_0 and the perturbation H′ are defined in such a way that they are separately permutation-invariant. First- and second-order results are compared with those obtained by Eisenschitz and London for nonorthonormal basis functions, and with those derived from a Brillouin expansion. (auth)

43818 TRANSITION MATRIX ELEMENTS FOR LARGE MOMENTUM OR ENERGY TRANSFER. Rau, A. R. P.; Fano, U. (Univ. of Chicago). Contract AT(11-1)-1674. Phys. Rev., 162: 68-70(Oct. 5, 1967). (COO-1674-1).

The radial matrix element $M = \int_0^\infty R_{kl}(r) j_L(qr) R_{nl}(r) r^2 dr$, which appears in collision theory and photon absorption ($L = 1$, $q \sim 0$), has been studied in the past for hydrogenic wave functions. Its behavior for large q or large k is now shown to depend only on the expansion of the wave functions near the nucleus and on an application of selection rules. For large q, the trend is $M \propto q^{-(l+1+4)}$ and for large k and normalization per unit energy, $M \propto k^{-(l+L+7/2)} q^{L}$. The asymptotic trend of Altshuler's equivalent forms of the matrix elements is discussed. (auth)

43819 PRESSURE SHIFTS OF HIGHLY EXCITED STATES OF ATOMS. Mittleman, M. H. (Univ. of California, Berkeley). Phys. Rev., 162: 81-7(Oct. 5, 1967).

A reinvestigation is given of Fermi's work on the shift of highly excited states of atoms embedded in a gaseous medium due to the interaction of the active electron with the medium particles. For the case treated by Fermi, spherically symmetric medium particles, it is found that effects neglected by him cancel and that his results are essentially correct. The method is extended to the case where the medium is composed of diatomic molecules, and it is shown that when rotational excitation is not important, only low-energy elastic scattering contributes in a manner similar to the spherically symmetric scatter. A simple two-rotational-state model is also analyzed in the case where rotational excitation may be important. It is concluded from the model that when the method used is applicable, real rotational coupling is never important. (auth)

43820 COMPOUND-STATE RESONANCES IN ATOM-DIATOMIC MOLECULE COLLISIONS. Micha, David A. (Univ. of Wisconsin, Madison). Phys. Rev., 162: 88-97(Oct. 5, 1967).

The theory of atom-diatomic molecule collisions has been extended to include the coupling between open- and closed-channel states by means of the effective-Hamiltonian method as developed by Feshbach. The results have been used to discuss in detail compound-state resonances at energies below the first excitation threshold. Calculations are presented for the Xe + H_2 and Xe + D_2 systems. They suggest that compound-state resonances may be observable in molecular-beam experiments. These resonances are found to depend primarily upon the short-range anisotropic part of the interaction potential. (auth)

43821 SLOW HEAVY-PARTICLE COLLISION THEORY BASED ON A QUASIADIABATIC REPRESENTATION OF THE ELECTRONIC STATES OF MOLECULES. O'Malley, Thomas F. (General Research Corp., Santa Barbara, Calif.). Phys. Rev., 162: 98-104(Oct. 5, 1967).

Collisions between heavy particles that entail a change in electronic state (such as changes in ionization or excitation) are considered in the low-velocity ($v \ll 1$ a.u.) region. The electronic part of the problem is treated in a way that is exact and at the same time lends itself most directly to the solution of the collision problem. This is done by introducing an exact but nondiagonal representation of the electronic Hamiltonian H_{el} for the molecular system. The basis states, which are a generalization of the resonant and potential scattering states of resonance theory, are not constrained by the noncrossing rule. Using these states as an expansion basis, the full Schrödinger equation for the collision is reduced to an effectively finite set of coupled two-body equations for the heavy-particle motion. The only approximation made, aside from small velocity, is the Born–Oppenheimer approximation. Therefore, both the electronic problem and the resultant problem of coupled heavy-particle motions may be treated with an accuracy that should be comparable with that of the corresponding molecular-stationary-state calculations. (auth)

43822 CORE REARRANGEMENT AND HARTREE–FOCK IONIZATION ENERGIES. Chow, P. C.; Kleinman, Leonard (Univ. of Southern California, Los Angeles). Phys. Rev., 162: 105-7(Oct. 5, 1967).

The energy to strip all the valence electrons from an atom consists not only of the one-electron valence energies minus $\frac{1}{2}$ the valence-electron–valence-electron interaction energy but also contains a contribution from the rearrangement of the core electrons upon ionization. Although this is a second-order contribution, it is second order in the core energy and therefore not necessarily negligible compared with valence energies. Self-consistent Hartree–Fock calculations were made for Li, Li^+, Be, Be^{++}, Mg, and Mg^{++}, computing separately for each electron its kinetic energy, nuclear Coulomb energy, core-electron Coulomb energy, valence-electron Coulomb energy, core-electron exchange energy, and valence-electron exchange energy. In Li and Be, core rearrangement decreased the ionization energy by less than 0.0001 Ry. In Mg, the s-core electron rearrangement increased the ionization energy by 0.1134 Ry while the p-core electron rearrangement decreased it by 0.1156 Ry for a total decrease of 0.0022 Ry. (auth)

43823 M_{IV} AND M_V ABSORPTION LINES AND EDGES OF Gd, Dy, AND Yb. Zandy, Hassan F. (Univ. of Bridgeport, Conn.). Phys. Rev., 162: 1-4(Oct. 5, 1967).

The M_{IV} and M_V edges of Gd, Dy, and Yb were measured using a high-intensity-focusing x-ray spectrograph operating in vacuum. An absorption line is detected on the long-wavelength side of the M_{IV} edge of Gd and a weaker one at the M_V edge of Dy. For Yb, however, the M_V absorption has the appearance of a strong white line. No absorption line has been observed at the M_V edge of Gd nor at the M_{IV} edges of Dy and Yb. The significance of the occurrence and absence of absorption lines in the filling of the 4f shell of the heavy rare earths and the effect of the absorber thickness on the shape of the absorption profile are discussed. (auth)

43824 INTERFERENCE OF FINE-STRUCTURE LEVELS OF He^+. Bickel, William S.; Bashkin, S. (Univ. of Arizona, Tucson). Phys. Rev., 162: 12-15(Oct. 5, 1967).

Passage of a beam of foil-excited He^+ ions through a small electric field induced quasiperiodic fluctuations in the intensity of the light emitted from levels n = 7, 8, 9, and 10. Both ^3He and ^4He beams were used. Only one foil was needed, in contrast to the double-foil arrangement reported necessary for hydrogen. The observations are discussed in terms of Stark-induced interference of the fine-structure levels of He^+, but discrepancies between the data and the calculations are large. (auth)

43825 PHENOMENON OF THE METASTABLE STATE COHERENTLY EXCITED BY ELECTRON IMPACT. Hadeishi, Tetsuo (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 162: 16-22(Oct. 5, 1967). (UCRL–17466).

Detailed information is given on an experiment reported previously, studying intensity beats in the resonance absorption due to nondegenerate magnetic sublevels of the $^3P_1$ mercury metastable state coherently excited by electron impact. Rather straightforward theory is used to explain the experimental result. It is found that regardless of the excited energy, as long as there is sufficient selective excitation of certain magnetic sublevels, the absorption beat frequency is modulated at twice the Larmor frequency when the incident electron beam is perpendicular to the externally applied field H_0 and the linearly polarized monitoring light is perpendicular to the electron beam. (auth)

43826 RESONANCE SCATTERING OF LIGHT FROM ATOMIC HYDROGEN. Himmell, Lewis C.; Fontana, Peter R. (Univ. of Michigan, Ann Arbor). Phys. Rev., 162: 23-8(Oct. 5, 1967).

The angular distribution of scattered Lyman-α photons from atomic hydrogen is calculated as a function of an applied magnetic field. The intensity of the scattered radiation is a function of the energy difference of the excited-2P levels and shows an extremum at the point where two levels cross. Neglecting hyperfine structure, there are two level crossings of interest: one at 3484 G ($2P_{\frac{1}{2},-\frac{1}{2}}$–$2P_{\frac{1}{2},\frac{1}{2}}$), and the other 5223 G ($2P_{\frac{1}{2},-\frac{1}{2}}$–$2P_{\frac{1}{2},-\frac{1}{2}}$), respectively. The coherent and incoherent resonance scattering is determined near these crossing points by using a Hamiltonian that includes hyperfine structure and higher-order radiative effects. In the low-field region (3484 G), the hyperfine crossings that contribute to the coherent signal are at 3476.06 and 3491.93 G, respectively. The radiative width of the levels is considerably larger than the hyperfine splittings, and the total scattering intensity has a single peak at 3483.97 G. In the high-field region (5223 G), two hyperfine levels with $m_F = -1$ repel each other (anticross) with a minimum energy separation of 15.3 Mc at 5200.1 G. Resonances occur at 5220.6 and 5223.9 G, and the masimum of the total signal is at 5222.6 G. (auth)

43827 ATOMIC SHELL THEORY RECAST. Judd, B. R. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-1447. Phys. Rev., 162: 28-37(Oct. 5, 1967). (NYO–1447-27).

Conventional shell theory for the electronic configurations l^N rests on the separation of the spin and orbital spaces according to the scheme $U(4l + 2) \supset U(2) \times U(2l + 1)$. If the total spin quantum number S is abandoned, the more symmetrical reduction $U(4l + 2) \supset U(2l + 1) \times U(2l + 1)$ can be adopted, corresponding to the separation of electrons whose spins point up from those whose spins point down. The orbital structure of a representation $[\lambda]$ of $U(2l + 1)$ can be carried over from ordinary shell theory; but the quantum numbers L_A and L_B in a typical coupled state $|([\lambda_A]L_A \times [\lambda_B]\, L_B)\, LM_LM_S\rangle$ are only pseudoorbital. The existence of two distinct spaces, each dimension $(2l + 1)$, leads to many simplifications in the theory. States of the f shell can be classified unambiguously. The spin–orbit splitting of terms near the Russell–Saunders limit is easy to calculate; no fractional parentage coefficients are necessary. What is especially remarkable is that L_A and L_B are sometimes quite good quantum numbers, and this makes it possible to give simple explanations for many regularities in the energy-level patterns for configurations of the type f^N. (auth)

43828 MAGNETOELECTRIC SUSCEPTIBILITIES OF S-STATE ATOMIC SYSTEMS. Lyons, J. D. (Univ. of California, Riverside); Hurst, R. P. Phys. Rev., 162: 38-45(Oct. 5, 1967).

A study is made of the effect on $^1S_0$ atomic systems of the simultaneous interaction of uniform electric and magnetic fields. It is found that in addition to the conventional magnetic-susceptibility and electric-polarizability terms there exists an interaction term in which the energy depends quadratically on both fields. The coefficient of this term in the energy is defined here as the magnetoelectric susceptibility. The magnetoelectric susceptibilities

of a large number of two-, four-, ten-, twelve-, eighteen-, and twenty-electron atomic systems are calculated. Analytical Hartree–Fock wave functions are used. The calculations are carried out using double-perturbation theory within the Hartree–Fock framework. The results show that the energy terms described by the magnetoelectric susceptibilities are of the same order of magnitude as those corresponding to the hyperpolarizabilities for magnetic fields of the order of 10^6 G. The magnetoelectric susceptibility effect is dependent on the relative orientation of the two fields, and its behavior with respect to field orientation is described by a property defined as the anisotropy. It is found that the magnetoelectric susceptibilities of the inert-gas isoelectronic-series systems are all negative and decrease in magnitude as the fields are rotated from perpendicular to parallel. The alkaline-earth systems show considerable variation: some are positive, some are negative, and in some the sign depends upon the relative orientation of the fields. (auth)

43829 SELECTING THE DIMENSIONS FOR THE BEAM CROSS SECTION IN VARIOUS ELECTRON-BEAM DEVICES. Kratirov, I. A. Tr. Nauch.-Tekh. Konf. Leningrad. Elek.-Tekh. Inst. Svyazi, No. 2, 116-23(1964). (In Russian).

The principle of current modulation by beam deflection is discussed. A circuit is described which consists of two flat capacitors lying in a single plane and separated by a narrow gap. The modulation characteristics of this type of system depend on the transverse dimensions of the beam and on the ratios of the capacitor voltages. Exact and approximate equations are derived for the modulation characteristics and data are given which may be used to evaluate the error of the approximate formulas. A system consisting of three flat capacitors is also considered. (tr-auth) (ATD)

43830 INTENSITY BEATS IN RESONANCE RADIATION AND ABSORPTION DUE TO COHERENT EXCITATION OF ATOMS BY ELECTRON IMPACT. Hadeishi, Tetsuo (Univ. of California, Berkeley). pp 291-5 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Intensity beats were observed in the resonance luminescence arising from the interference of electromagnetic-field quanta that are emitted from the coherently excited nondegenerate magnetic sublevels of the excited state of atoms that are formed by sharply pulsed, low-energy, unidirectional electron beams. In a metastable state, a similar effect was obtained by monitoring the beats in the resonance absorption. Since a large concentration of the coherently excited metastable states are required in the absorption experiment, a space-charge neutralized, high-flux unidirectional, low-energy, high-frequency modulated electron beam was used. (auth)

43831 EFFECTS OF Ar^+ AND Kr^+ ION BOMBARDMENT ON THE SURFACE STRUCTURE OF Ge, Si, AND Cu. Jacobson, R. L. (Litton Systems, Inc., Minneapolis). pp 26-8 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Single crystal targets of Ge, Si, and Cu were bombarded with Ar and Kr ions in a low-pressure high-density dc discharge and their effect on surface structure was studied in situ with low-energy electron diffraction (LEED). Surface orientations included Ge(100) and (111), Si(111), and Cu(100) and (110). Experiments were carried out in a bakeable vacuum system. (M.O.W.)

43832 ELECTRON EMISSION FROM W AND Mo BOMBARDED BY 50 TO 400 eV Ar^+ AND He^+. Vance, Dennis W. (Xerox Corp., Rochester, N. Y.). pp 90-4 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Measurements were made of the yield of secondary electrons ejected from polycrystalline Mo targets bombarded by Ar^+ and He^+ in the energy range 50 to 400 eV. The results of previous investigators have been reproduced and the discrepancies are shown to be due to the failure of heating alone to remove carbon present in the target as an impurity. (M.O.W.)

43833 STUDIES OF THE SECONDARY ELECTRON EMISSION YIELD, ENERGY, AND ANGULAR DISTRIBUTION FROM HIGH RESISTANCE TARGETS AT GRAZING ANGLES OF INCIDENCE. Goff, R. F.; Hendee, C. F. (Bendix Research Labs., Southfield, Mich.). pp 231-8 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

In the continuous dynode channel electron multiplier, electron impacts occur at near grazing angles of incidence. Methods and apparatus are described which enable the complete secondary electron emission parameters of a target of high resistance dynode material to be accurately measured at extreme grazing angles of incidence under field free conditions. Secondary electron energy distributions are directly obtained by using an ac modulating technique to differentiate the retarding potential curves. Experimental results are obtained for primary beam currents as low as 10^{-9} A and beam energies between 50 and 700 eV for angles of incidence varying from normal to within 15° of grazing. The angular distributions are measured to an angular resolution of less than 1 degree by scanning a small apertured channel electron multiplier along a longitudinal slit in the collector. (auth)

43834 DIFFERENTIAL THICKNESS CURVES OF ELECTRON BACKSCATTERING FROM THE TWO-LAYERED TARGET Be–Au. Nakhodkin, N. G.; Melnik, P. V.; Elizarov, A. I. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 1160-5(July 1967). (In Russian).

A comparison was made of the experimental and calculated thickness curves of electron backscattering from the two-layered target Be–Au. The calculations are performed within the limits of an approximate model of continuous losses. The initial energy of the electrons was $E_0 = 5.9$ keV. Electrons with the given energy $\epsilon = E/E_0$ scattered to the angle π within the narrow solid angle were recorded during measurements. Such thickness curves are called differential. Differential thickness curves of the electron backscattering make it possible to estimate approximately the relative range straggling and the range of electrons itself. (auth)

43835 STIMULATED EMISSION OF ELECTRONS MOVING IN A MAGNETIC FIELD. Ternov, I. M.; Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 43-7(1967). (In Russian).

An investigation was made of the stimulated emission of electrons moving in a homogeneous and constant magnetic field with a relativistic velocity during irradiation by an electromagnetic wave with a frequency ω. Such electrons constitute a quantum system which obeys the laws of the quantum theory (macroatom). Spontaneous transitions of electrons to lower energy levels produce synchrotron radiation. Irradiation of electrons with an external electromagnetic wave stimulates forced quantum transitions, making possible a new type of quantum amplifier. Recently such an amplifier was realized experimentally. It was shown that the effect of stimulated emission can be obtained not only on the fundamental frequency, but also on higher harmonics in the case when the electron moves at a relativistic velocity. The form and width of the line play the dominant role in the effect of stimulated emission of electrons. The factors determining the width of the line are: (1) radiative damping, (2) the Doppler effect, (3) electron collisions, and (4) flight time. The emission intensity of a harmonic with the number λ has an order of $\beta^{2\lambda-1}$. At small β (nonrelativistic electron), generally only the dipole transitions contribute to the emission (the same as in spontaneous emission). In the case of relativistic electrons, there is the possibility of obtaining stimulated emission on higher harmonics of the fundamental frequency. (ATD)

43836 IONIZATION OF CO_2 AND N_2O BY ELECTRON IMPACT. Carette, Jean-Denis (Univ., Laval, Quebec). Can. J. Phys., 45: 2931-8(Sept. 1967). (In French).

The ionization curves of CO_2 and N_2O caused by electronic impact have been measured for various ranges of ionizing electron energy. For both ions, CO_2^+ and N_2O^+, a structure consisting mainly of breaks in the curve has been observed. Some of those breaks have been related to excited electronic states of the ions, and others, near threshold, to vibrational states. (auth)

43837 PRESSURE-INDUCED INFRARED ABSORPTION OF GASEOUS HYDROGEN AND DEUTERIUM AT LOW TEMPERATURES. II. ANALYSIS OF THE BAND PROFILES FOR HYDROGEN. Watanabe, A. (Univ. of Toronto, Ont. Telecommunications Establishment, Ottawa); Welsh, H. L. Can. J. Phys., 45: 2859-71(Sept. 1967).

Experimental profiles for the pressure-induced fundamental infrared band of hydrogen for a number of temperatures in the range 18 to 77°K were analyzed by a computational procedure. Half widths and peak intensities of 11 components, assumed to have a Boltzmann-modified dispersion line form, were obtained from the analysis. The contributions of the quadrupolar and overlap interactions to the total intensity, as well as their variation with temperature, showed good agreement with theoretical calculations on the exp-4 model. (auth)

Cosmic Radiation

Refer also to abstracts 42964, 43233, and 43920.

43838 (N-67-22876) OBSERVATIONS OF NUCLEI HEAVIER THAN IRON IN THE PRIMARY COSMIC RADIATION. Ormes, J. F.; von Rosenvinge, T.; Webber, W. R. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). Jan. 1967. 9p. (NASA-CR-83419; CR-92). CFSTI.

Systematic studies of the charge and energy spectra of primary cosmic rays with a large area Cherenkov scintillation counter on over 10 balloon flights have yielded new limits on the intensity of nuclei significantly heavier than iron. In the course of identifying over 2000 events as due to iron-group nuclei, two events which could possibly be related to nuclei with $Z \geq 36$ have been observed. A lower limit of 1000:1 for the ratio of these groups of nuclei is obtained along with an upper limit to the intensity of $Z \geq 36$ nuclei of 4×10^{-6}/cm^2-ster-sec. The details of these measurements and some of their astrophysical implications are discussed. (STAR) (auth)

43839 (N-67-23276) ACCELERATION OF COSMIC RAYS IN INTERPLANETARY SPACE BY FRICTION WITH THE SOLAR WIND. Lenchek, A. M.; Goldstein, M. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct. 1966. 25p. (NASA-CR-83549; TR-630). CFSTI.

The interaction between galactic cosmic rays and the steady solar wind is studied. In the steady state the cosmic rays form a stationary cosmic-ray gas through which massive magnetic irregularities are carried by the solar wind. Collisions between the streaming irregularities and the stationary cosmic-ray gas transfer energy and momentum to the cosmic rays. The cosmic ray gas in the solar environment is thereby heated by friction with the solar wind that flows through it. In the steady state the average cosmic rays near the earth are more energetic than they were in interstellar space by a factor that is less than three. (auth) (STAR)

43840 COMMENTS ON RADIO-FREQUENCY AND OPTICAL BREMSSTRAHLUNG FROM EXTENSIVE COSMIC-RAY SHOWERS. Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25A: 346-7(Sept. 11, 1967).

Various aspects of the production of radio-frequency and optical bremsstrahlung in extensive air showers are discussed. It is concluded that these radiations will be incoherent and that the intensities are insignificant compared with contributions from the other mechanisms proposed. (auth)

43841 FLUX OF SLOW NEUTRONS IN ATMOSPHERE. Kuchowicz, Bronislaw (Univ., Warsaw). Postepy Fiz., 18: 459-61(1967). (In Polish).

Results are given of measurements of the flux of slow neutrons with energies from thermal up to 100 keV. They were performed with the help of balloons in the years 1960-62 in Yakutsk. Counters filled with BF_3 were used to measure the neutron flux intensity. From six balloon flights the height distribution of the neutron flux in dependence on the atmospheric pressure was deduced. In a figure the results are compared with those of earlier experiments which were performed under similar conditions, and with detectors sensitive in the same energy region. The agreement may be regarded as good, though the experimental values come from the years from 1948 up to 1962. The disagreement between the results obtained with the help of balloon flights and via airplanes is discussed. (auth)

43842 THE FEBRUARY 5, 1965, SOLAR PROTON EVENT. I. TIME HISTORY AND SPECTRUMS OBSERVED AT 1100 KILOMETERS. Bostrom, C. O. (Johns Hopkins Univ., Silver Spring, Md.); Kohl, J. W.; Williams, D. J. J. Geophys. Res., 72: 4487-95(Sept. 1, 1967).

The solar proton event of February 5, 1965, was observed in the polar regions with detectors aboard 1963 38C. The initial detection of protons occurred during the pass at 1914 UT, February 5, and the maximum intensity of 115 cm^{-2} sec^{-1} for $E_p \geq 25$ MeV was seen during the pass at 2103 UT, February 5. The time history of the low-energy protons ($E_p \geq 1-2$ MeV) was considerably more complex than that of the higher energy particles. The maximum observed intensity ($E_p \geq 2$ MeV) was equal to 775 cm^{-2} sec^{-1} at 0232 UT, February 6, and a second maximum was observed following the onset of the magnetic storm on February 6. For the higher energies the particle flux decayed approximately exponentially in time with the shorter "lifetimes" associated with the higher energies. An attempt to fit the time history with diffusion theory using a diffusion coefficient of the form $D = Mr^5$ was moderately successful for $E_p \geq 25$ MeV. The spectrum showed a (nearly) monotonic softening with time, and a power law generally provided a better approximation to the spectrum than did an exponential form. (auth)

43843 OBSERVATIONS OF FEBRUARY 5 TO 12, 1965, SOLAR PARTICLE EVENT WITH MARINER 4 AND INJUN 4. Krimigis, S. M.; Van Allen, J. A. (Univ. of Iowa, Iowa City). J. Geophys. Res., 72: 4471-86(Sept. 1, 1967).

The solar cosmic-ray event of February 5-12, 1965, was the most intense one of a 10-month period of interplanetary observation (November 28, 1964, to September 30, 1965) with Mariner 4 during the recent epoch of minimum solar activity. A full time history of the intensities of energetic particles is presented from onset at 1835 ± 10 UT on February 5, following a 2$^+$ solar flare NO8, W25 (which began at 1750 UT) until disappearance into the background near the end of February 12. A mixture of low-energy protons $E_p > 0.5$ MeV and electrons $E_e > 40$ keV is identified in this event for the first time. Maximum values of intensities of particles early in the event are given. Simultaneous observations with similar equipment on the near-earth satellite Injun 4 are compared with those of Mariner 4. It is found that the time histories of the intensities of both low-energy, $E_p \sim 1$ MeV, and higher-energy, $E_p \sim 55$ MeV, protons over the polar caps of the earth are similar to those at a position 0.15 AU from the earth. The propagation of protons with $E_p > 55$ MeV is apparently diffusive, with a diffusion coefficient increasing with heliocentric radial distance at $r^{\frac{1}{2}}$. Propagation of the low-energy protons is not consistent with any simple model of interplanetary diffusion. The time profile of these particles reveals a spatial structure of $\sim 4 \times 10^{-5}$ km. Such particles are shown to have been distributed over a heliocentric longitudinal range of at least 70° in interplanetary space if the model of solar corotation of a general magnetic field line structure is taken to govern the time history of their intensity. The time history of the intensity of low-energy electrons is also presented. (auth)

43844 ANISOTROPIC DIFFUSION OF SOLAR COSMIC RAYS. Burlaga, Leonard Francis (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 72: 4449-66(Sept. 1, 1967).

A mathematical model is presented, and a relatively simple solution is obtained that describes the basic characteristics of solar cosmic-ray propagation. The model postulates that solar cosmic rays diffuse anisotropically in the interplanetary medium because of the irregular spiral interplanetary magnetic field. It is assumed that the diffusion coefficient along the field direction is constant up to an effective absorbing boundary at r_1, where r_1 is found to be approximately 2 AU, and that the diffusion coefficient perpendicular to the field lines increases with distance from the sun because of the diminishing magnetic field intensity. The solution of the diffusion equation with these conditions is found to depend significantly on the solar longitude of the flare that produces the cosmic rays. Excellent intensity-versus-time fits are obtained for the events of Feb. 23, 1956; Aug. 22, 1958; May 4, 1960; Sept. 3, 1960; Nov. 15, 1960; Nov. 20, 1960; July 18, 1961; July 20, 1961; and Sept. 28, 1961. It is demonstrated that the solution of the diffusion equation does apply during the anisotropic phase of several events. The model is consistent with several east-west effects that have been observed. (auth)

43845 THE FEBRUARY 5, 1965, SOLAR PROTON EVENT. II. LOW-ENERGY PROTON OBSERVATIONS AND THEIR RELATION TO THE MAGNETOSPHERE. Williams, D. J. (Goddard Space Flight Center, Greenbelt, Md.); Bostrom, C. O. J. Geophys. Res., 72: 4497-4506(Sept. 1, 1967).

Observations of the temporal and spatial behavior of low-energy (~1-MeV) solar protons are presented for the solar proton event of February 5, 1965, utilizing data from the near-earth satellites 1963 38C and Injun 4 and spaceprobe Mariner 4. An enhancement of low-energy proton intensities is observed at invariant latitudes $\Lambda \gtrsim 80°$ and may be a low-latitude effect of the high-latitude topology of the magnetopause. Comparison of the polar cap and Mariner 4 observations indicate that the magnetospheric configuration varies as the boundary conditions imposed by the interplanetary medium vary, thereby causing marked structure in the polar cap and Mariner 4 observations are presented and discussed in terms of (1) a filamentary interplanetary field structure and (2) an extended geomagnetic tail. Depending on the assumptions, either approach is consistent with the data. It is also indicated that particle motion across interplanetary field lines near the solar surface or in the region of the shock front is required to explain the low-energy proton arrival times in the vicinity of the earth. (auth)

43846 COSMIC-RAY PROPAGATION PROCESSES. II. THE ENERGETIC STORM-PARTICLE EVENT. Rao, U. R.; McCracken, K. G.; Bukata, R. P. (Southwest Center for Advanced Studies, Dallas, Tex.). J. Geophys. Res., 72: 4325-41(Sept. 1, 1967).

Seven examples of the observation of intense fluxes of ≈10-MeV charged particles associated with disturbances in the interplanetary medium during 1966 are discussed, and detailed data from four of them are presented. It is shown that there is an approximately one-to-one correspondence between such events and the onset of Forbush decreases initiated by solar flares. The particle fluxes exhibit characteristic time profiles, with a typical time scale of 6 hours. The particle fluxes are strongly anisotropic, and the direction of the anisotropy shows drastic temporal

variations during the onset of the Forbush decrease. The fluxes of particles of energy ≈10 MeV are frequently considerably greater, while the energy spectra are usually noticeably softer than those observed during the preceding flare effect. A bidirectional anisotropy is commonly observed following the decreasing intensity phase of a Forbush decrease, the two directions of maximum flux being aligned parallel and antiparallel to the interplanetary magnetic field vector. It is shown that the energetic storm particles do not suffer any significant trapping in the magnetic regime associated with the onset of the Forbush decrease. It is shown that the various facts are consistent with the Parker "blast wave" model for the interplanetary magnetic field associated with the Forbush decrease, while the Gold "magnetic bottle" model is unable to explain the observed temporal variations in the anisotropic character of the particle fluxes. Studies of the net particle flux moving radially away from the sun suggest that the energetic storm particles are suffering acceleration within the magnetic field (i.e., within the shock front) associated with the onset of the Forbush decrease. It is suggested that the recurrent low-energy cosmic-ray events observed by other workers might consist of energetic storm particles associated with recurrent Forbush decrease events. (auth)

43847 COSMIC-RAY PROPAGATION PROCESSES. I. A STUDY OF THE COSMIC-RAY FLARE EFFECT. McCracken, K. G.; Rao, U. R.; Bukata, R. P. (Southwest Center for Advanced Studies, Dallas, Tex.). J. Geophys. Res., 72: 4293-4324 (Sept. 1, 1967).

Observations of the cosmic radiation generated by solar flares are used to study the propagation of cosmic rays through the interplanetary magnetic field. The observations were made by cosmic-ray detectors flown on two indentical interplanetary spacecraft, Pioneers 6 and 7. The detectors determined the directional, energy, and temporal characteristics of the cosmic radiation of energy greater than 7.5 MeV. It was found that cosmic radiation of solar origin is normally extremely anisotropic, the direction of maximum flux being aligned parallel to the interplanetary magnetic field vector at early times during flare effects. At late times a persistent anisotropy of amplitude 5 to 10% is observed, the maximum flux arriving from the sun–spacecraft direction. It is argued that at late times the cosmic radiation is in diffusive equilibrium, and an explanation for the persistent anisotropy is advanced in terms of expulsion of the cosmic radiation from the solar system by the combined action of the solar wind and a cosmic-ray density gradient. It is shown that the cosmic-ray fluxes and their anisotropic characteristics are sometimes very greatly influenced by interplanetary conditions, and may exhibit strong spatial inhomogeneities. It is shown that the low-energy cosmic rays tend to remain identified with the magnetic tube of force onto which they are initially injected, this being the equivalent to saying that they corotate with the Sun. Under some circumstances, the propagation of cosmic rays from the Sun to the orbit of Earth is completely dominated by a "bulk motion" propagation mode, in which the cosmic rays do not gain access to the spacecraft until the magnetic regime into which the cosmic rays are injected envelops the spacecraft. This bulk motion propagation mode applies both to magnetic regimes initiated by solar flares and to the regimes associated with recurring Forbush decreases, the latter being long-lived field structures imbedded in the normal solar wind. In two cases, it is shown that the anisotropy directions and cosmic-ray times of flight are such as to indicate diffusion of the cosmic rays to a point on the western portion of the solar disk before injection onto the field line that carried them to the spacecraft. The temporal decay of a cosmic-ray flare effect subsequent to impulsive injection by a solar flare is studied, an example being presented in which the decay was essentially exponential over a period of time equal to 9.2 decay time constants. Simultaneous observations by both spacecrafts when separated by about 54° in solar azimuth indicate azimuthal cosmic-ray density gradients in excess of two orders of magnitude per 60° for extended periods during the initial phases of flare effects. By studying the rate at which a known cosmic-ray flux propagating away from the Sun was backscattered so as to return to the spacecraft from the antisun direction, the mean free path for large-angle scattering in the inner solar system is shown to be of the order of 1.0 AU. The application of an isotropic diffusion model to the same data is shown to yield much lower values of mean free paths, and it is argued that this latter method is, in most cases, inapplicable. (auth)

Direct Energy Conversion

Refer also to abstract 44856.

43848 (N-67-21161) RESEARCH IN ELECTROHYDRODYNAMICS AND TRAVELING-WAVE ELECTROMECHANICAL ENERGY CONVERSION. Semiannual Report, August 1, 1966–January 31, 1967. Melcher, James R. (Massachusetts Inst. of Tech., Cambridge. Dept. of Electrical Engineering). 16p. (NASA-CR-83114). CFSTI.

Summary reports are given of research in the field of continuum electromechanics of field-coupled systems, with emphasis on electrohydrodynamics, including such topics as charge relaxation on a moving liquid interface, electrohydrodynamic relaxation surface instabilities, containment of dielectric fluids with rotation, free-charge instability of a dielectrophoretically oriented fluid, thermally induced electrohydrodynamic bulk instability, static field-gradient electroconvection, feedback control of electromechanical systems. Investigations in traveling-wave electromechanical energy conversion are also summarized. (STAR)

43849 (N-67-25755) SERIES VII SOLAR ENERGY THERMIONIC CONVERTER DEVELOPMENT PROGRAM. Final Report. Merra, S. (Thermo Electron Engineering Corp., Waltham, Mass.). Feb. 1964. Contracts NAS7-100; JPL-950228. 170p. (NASA-CR-83843; TE-48-64). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Development is reported for an improved mechanical design which simplifies the method of manufacture to the extent that the end product is a less complex unit and more amenable to complete quality control. In order to enhance the probability of successful life testing, and to remove any external effects, five specially manufactured life test stands, with completely integrated auxiliary equipment, were constructed and used for testing. The developed converters were placed on life test and exceeded 3000 hours of operation. It is reported that three experimental converters were also constructed and tested. (STAR)

43850 (N-67-25876) SOLAR THERMIONIC GENERATOR DEVELOPMENT. Quarterly Report, December 1, 1966–February 28, 1967. (Thermo Electron Engineering Corp., Waltham, Mass.). Mar. 1967. Contract NAS7-100. 18p. (NASA-CR-83886; TE-4055-94-67). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

A second collector–radiator model was fabricated and tested to evaluate converter design modifications aimed at the reduction of collector temperature. This effect showed that the modified converter structure should be capable of maintaining collector temperatures below 1030°K at output currents up to 72 amperes. Previously, the collector temperature of converter T-205 had been observed to reach 1043°K at an output current of 49.3 amperes. Other work performed under the program comprised the evaluation of vanadium as a braze material to join rhenium to niobium, and the comparison of the strength of nickel–gold eutectic braze with that of a palladium–silver–copper alloy for the joining of copper to molybdenum. These braze tests showed that vanadium is a suitable braze material for joining rhenium to niobium, and that the nickel–gold eutectic has far stronger adherence to molybdenum than does the palladium–silver–copper alloy. (auth) (STAR)

43851 (N-67-25898) HEAT PIPE THERMIONIC CONVERTER DEVELOPMENT. Quarterly Report, October 1, 1966–January 10, 1967. (Thermo Electron Engineering Corp., Waltham, Mass.). Contracts NAS7-100; JPL-951465. 22p. (NASA-CR-83920; TE-4067-76-67). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Progress is reported on the development of a converter which incorporates a heat pipe concept to transfer heat between the collector and the radiator. Four devices are being fabricated and tested to insure a thorough evaluation of each design before proceeding with the next. The first two designs include only the heat pipe, while the latter two are complete converter structures with the heat-pipe collector radiator. The efforts during this period were concerned with the fabrication of the first of the two heat pipe models. (auth) (STAR)

43852 (N-67-25942) OPERATION OF AN MHD POWER GENERATOR. Semiannual Report, June 1–December 1, 1966. Townsend, Stanley J. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Mar. 1, 1967. 13p. (NASA-CR-83900). CFSTI.

The graphite heater has been heated up to a few hundred degrees above room temperature. This has proved the integrity of the electrical system and the lack of short circuits of the electrodes against the rest of the graphite heater. Heating to temperatures near the oxidation limit of graphite could not be attempted until the heater could be evacuated. This was attempted by pumping the vacuum sphere down to 20 torr and then cracking the upstream valve until a very faint air flow could be heard. Even this flow proved too large since about two cubic feet of lampblack were pulled downstream. The lampblack is now being removed completely and will be replaced by graphite felt. The large electro-

magnet facility will be operating well before the heater and the coils are nearing completion. The seeding mechanism has been designed to allow any seed of the Cs, NaK, K_2CO_3, or KOH family to be used interchangeably. It is now being fabricated in the machine shop. The initial channel is being fabricated out of alumina brick and stainless steel welded box sections. Six equal sections totalling two meters in length have been fabricated and are awaiting the installation of tungsten electrodes. (auth) (STAR)

43853 (N-67-26176) THERMIONIC RESEARCH AND DEVELOPMENT PROGRAM. Semiannual Progress Report. Campbell, A. E. (Electro-Optical Systems, Inc., Pasadena, Calif.). Feb. 4, 1967. Contract NAS7-514. 62p. (NASA-CR-84004; EOS-7118-SA-1; SAPR-1). CFSTI.

For Jet Propulsion Lab., Pasadena, Calif.

Progress is reported on a program to improve the output performance of low-temperature thermionic converters by investigating optimized interelectrode spacing and electrodes yielding a low work function collector. The EOS variable parameter test vehicle was demonstrated to be sufficiently versatile to operate at wide spacings and low emitter temperatures without extensive redesign. Reproducible data from converter hardware and test vehicles proved the hypothesis that a higher bare work function material yields a lower cesiated work function, and that a lower collector work function yields a higher power output. The pressure distance of 16.0 ± 0.8 mil-torr was found to be independent of emitter temperature or collector materials. Two ultrahigh vacuum devices were designed and fabricated to characterize and assess the quality of vapor-deposited rhenium surfaces prior to committing them as electrodes in a thermionic converter. (STAR)

43854 (NASA-SP-153, pp 31-8) SHOT NOISE IN THE LAGRANGIAN ONE-DIMENSIONAL MODEL. Barnes, Christopher; Dunn, D. A. (Stanford Univ., Calif. Inst. for Plasma Research).

Results are presented of computer experiments designed to test the effects of coarse graining in the one-dimensional planar Langrangian computer simulation of a one-dimensional electron diode. (auth)

43855 (NP-tr-1573) ON THE OPTIMUM WIRING FOR AN MHD GENERATOR WITH FOUR ELECTRODES. Haeusler, Jochen. Translated by W. G. Stripp (Atomic Energy Research Establishment, Harwell, Eng.), from Elektrotech. Z., 87A: 754-60(1966). 23p. Dep. CFSTI. JCL $2.60 fs, $0.89 mf.

Some properties of doubly symmetric MHD channels with four electrodes are described. Operated as Faraday and cross-connected generators, these channels have the same maximum power output and the same maximum efficiency $\eta_{max} \leq 1$. With all magnetic fields Hall generators give not more than half the power output which can be taken from the Faraday or cross-connected generator and then have an efficiency $\eta_{max} \leq (\sqrt{2}-1)/(\sqrt{2}+1)$. If one output of a cross-connected generator is short circuited, the maximum efficiency is $\eta_{max} \leq \frac{1}{2}$. For the Faraday and cross-connected generators equivalent dimensions are given with respect to the efficiency. Finally, the power output and efficiency for a special arrangement are worked out exactly as functions of the Hall angle a. (auth)

43856 COLD ELECTRODE PERFORMANCE IN A MHD-GENERATOR CHANNEL. Vulis, L. A.; Goryachev, V. L.; Yaglenko, V. T. Teplofiz. Vys. Temp., 5: 689-93(July-Aug. 1967). (In Russian).

The performance of cold electrodes was studied and it was assumed that a finely dispersed emitting layer, of Knudsen number Kn > 1, precipitates on the cold electrode. It was noticed that the formation of a low-temperature film on electrodes with surface temperature comparably close to the plasma temperature significantly reduced the influence of the cold-electrode thermal boundary layer. (R.V.J.)

43857 SOME DATA ON EXPERIMENTS WITH MHD-GENERATOR MODEL WITH HALL EFFECT AND SECTIONAL ELECTRODES. Kazakevich, O. Ya.; Ustimenko, L. Yu.; El'kin, A. I.; Yantovskii, E. I. (Research Inst. of Power Tech., USSR). Teplofiz. Vys. Temp., 5: 684-8(July-Aug. 1967). (In Russian).

Experimental studies were carried out with an MHD generator with segmented electrodes. The current and voltage oscillograms of various loads and volt-ampere characteristics are given. Experimental data were collected for a new channel design, which is a modification of the present Hall and Montardi current generators. (tr-auth)

43858 STUDIES OF A ONE-DIMENSIONAL PLASMA FLOW IN THE CHANNEL OF MHD-ENERGY CONVERTER. Vulis, L. A.; Kusainov, M. K. Teplofiz. Vys. Temp., 5: 663-75(July-Aug. 1967). (In Russian).

Local ratios of variables were found for quasi-one-dimensional plasma flow in crossed fields with $Re_m \ll 1$ in a wide range of parameter magnitudes. (tr-auth)

43859 CALCULATIONS OF DISTRIBUTION OF POTENTIAL ALONG THE MHD-GENERATOR CHANNEL BY MEANS OF SUBSTITUTION SCHEME METHOD. Ustimenko, L. Yu. (Research Inst. of Power Tech., USSR). Teplofiz. Vys. Temp., 5: 676-83 (July-Aug. 1967). (In Russian).

Distribution of the potential along the channel of a Hall-current magnetohydrodynamic generator was calculated. The computed numerical data agree quantitatively with the experimental data. (tr-auth)

43860 MHD GENERATOR TESTED. EEI (Edison Elec. Inst.) Bull., 35: 116(Apr. 1967).

Operation of an experimental magnetohydrodynamic (MHD) generator under the 60-cycle ac conditions found in central station power plants is described. By passing a moving conductor, in this case a liquid metal, through a magnetic field, power was generated without use of moving or rotating mechanical parts. More than 7400 W of ac electric output were generated by the device, called a linear channel induction generator. The test operation was made both at a high frequency of 300 cps and at 60 cycles. Self excitation of the generator's magnetic field was achieved in the tests while the device supplied power to an external electrical load. Purpose of the project described was to investigate more efficient means of generating electric power by using the MHD concept in combination with nuclear or fossil fueled central station power equipment. An advantage of the liquid metal approach to MHD over systems of hot ionized gas is the lower operating temperature which permits the use of conventional construction materials such as stainless steel. The generator consisted of a stainless steel channel through which the liquid metal flowed. The magnetic field was produced by stators located outside of the channel, above and below. The excitation current generated a traveling magnetic field which induces current loops in the fast moving liquid metal. In large power plant application, the liquid metal would be heated to high temperatures and partially vaporized in a conventional boiler or by a nuclear reactor. The resulting stream then would be expanded through nozzles and passed through the magnetic field of the MHD generator, thereby producing electrical energy. (BBB)

43861 ON OPTIMAL WIRING OF AN MHD GENERATOR WITH FOUR ELECTRODES. Haeusler, Jochen (Siemens AG, Nuernberg, Ger.). Elektrotech. Z., A, 87: 754-60(1966). (In German).

Various properties of doubly symmetrical MHD channels with 4 electrodes are described. These channels used as Faraday and cross-wire generators have the same maximum output and the same maximum efficiency. $\eta_{max} \leq 1$. In the cross-wire generator the maximum efficiency is $\leq \frac{1}{2}$ if a load branch is shorted. Hall generators with 4 electrodes give, for all magnetic fields, maximally less than half of the power obtainable by the Faraday or cross-wire generator, and reach a maximum efficiency $\eta_{max} \leq (\sqrt{2}-1)/(\sqrt{2}+1)$. For the latter types equivalent measurements with respect to the efficiency are given. Power and efficiency as functions of the Hall angle α are calculated exactly for a particular arrangement. (BBB)

43862 ELECTRON RECOMBINATION AND THERMIONIC EMISSION IN NEGATIVELY CHARGED SOLID PARTICLES. Sodha, M. S.; Sharma, S. (Indian Inst. of Tech., New Delhi). Brit. J. Appl. Phys., 18: 1127-31(Aug. 1967).

The coefficient of recombination of electrons with negatively charged solid particles and the rate of thermionic emission from such particles are calculated by using an appropriate expression for the potential energy of electrons near the surface of the particles instead of the idealized relationship used in an earlier paper by Sodha [Brit. J. Appl Phys., 14: 172-6(1963)]. The results are discussed, together with relevant numerical data. (auth) (UK)

43863 CHARGED-PARTICLE PRODUCTION IN THE ELECTROGASDYNAMIC GENERATOR. Bailey, A. G. (Univ. of Southampton, Eng.). Electron. Lett., 3: 242-3(June 1967).

Experiments were performed on an electrogasdynamic generator utilizing charged water droplets produced by using an atomizer in an electric-field region. This method of charged-particle production may offer certain advantages over corona systems. The mechanism of induction charging is well understood and operates with a particularly simple electrode geometry. Problems of electrode erosion do not arise. (auth) (UK)

43864 ISOTOPE POWERED GENERATORS USING THERMOELECTRIC CONVERTORS. Poole, M. J. (Atomic Energy Re-

search Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc., 6: 206-18(July 1967).

The choice of materials for fuel, thermoelectric elements, insulation, and shielding are discussed. Generator design principles are considered, and the status of developments in the UK (RIPPLE), US (SNAP), Europe, and the USSR is reviewed. Estimates of the cost of generators are presented, and their possible applications are surveyed. (UK)

43865 TWENTY-SEVENTH ANNUAL CONFERENCE ON PHYSICAL ELECTRONICS, CAMBRIDGE, MASSACHUSETTS, MARCH 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967. 356p. $10.00. (CONF-670320).

Separate abstracts were prepared for 13 of the included articles. (M.O.W.)

For abstracts of individual papers see: 43613, 43830–43833, 43866–43871, 44044, and 44108.

43866 WORK FUNCTION DISTRIBUTION OF THERMO-EMISSIVE REFRACTORY LAYERS. Alleau, T. (CEA, Saclay, France); Shroff, A. M. pp 104-16 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Vapor-deposited refractory emitters thermally and electro-etched are discussed. An electron emission microscrope was used for work function investigation at 2000°K. Work function distribution are given for molybdenum, tungsten and rhenium. Corresponding plots are deduced for cesium-covered emitters. (auth)

43867 COMPUTER SOLUTION OF THERMIONIC CONVERTER TRANSPORT EQUATIONS. Hansen, L. K.; Warner, C. (Atomics International, Canoga Park, Calif.). pp 308-18 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

The plasma transport phenomena in a thermionic converter are described by a system of five simultaneous, nonlinear differential equations. These equations describe ion and electron particle transport, electron energy transport, and particle and energy continuity. Appropriate boundary conditions describe continuity at the electrodes. Electron–ion contributions to the transport coefficients are included, in the form developed by Nighan. Multistage ionization and recombination is treated according to the calculations of Norcross and Stone. Computer solutions have been obtained for this system of transport equations and boundary conditions. These calculations yield the spatial variation of plasma density, electrostatic potential, electron temperature, ion current, and electron energy flux. Sheath potentials are also obtained. (auth)

43868 XENON PRESSURE INDUCED CHANGES IN ELECTRON DENSITY AND TEMPERATURE IN A CESIUM PLASMA DIODE. Reichelt, W. H. (Los Alamos Scientific Lab., N. Mex.). pp 319-22 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Preliminary results obtained from spectrographic observations of an operating thermionic diode with xenon as an additive gas are presented. These observations yielded electron temperatures, densities, and attendant changes in these quantities as xenon was introduced. (M.O.W.)

43869 THE SELECTION OF SIMPLE MODEL ATOMS FOR CALCULATIONS OF ELECTRON DENSITY IN NONEQUILIBRIUM, LOW TEMPERATURE Cs PLASMAS. Dugan, John V. Jr. (Lewis Research Center, Cleveland). pp 323-31 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Free electron number densities N_e are calculated for cesium plasmas with low electron temperatures T_e(0.15 to 0.3 eV) using 5-, 3-, and 2-level atomic models. These N_e values are obtained for a Maxwellian distribution of free electrons; this distribution was shown to be a good approximation for $T_e > 2100°K$ in optically thick Cs plasmas. The sensitivity of N_e to the choice of electronic levels, statistical degeneracy and radiative capture coefficients is presented for plasmas either optically thin or thick to resonance radiation. The steady state equation for the electron number density is discussed in the limits of low and high neutral density N^0_{Cs}. The ionization fraction $f \equiv N/N^0_{Cs}$ was studied as a function of N^0_{Cs} for the range of T_e from 1740°K (0.15 eV) to 3000°K. Results are presented as a function of T_e for $N^0_{Cs} = 3 \times 10^{22}$ m^{-3} (typical values for certain thermionic diodes). Both sets of results are compared with the corresponding Saha curves for plasmas in local thermodynamic equilibrium (LTE). A discussion of rules for choosing reasonably accurate but simple atomic models is included. Those electronic levels which serve as free electron source terms are identified as functions of N^0_{Cs} for fixed T_e. Even a 5-level model gives N_e values which are only in fair agreement with optically thick results for a 26-level model under certain conditions. The lumped level degeneracy g_M can be made a function of N^0_{Cs} and T_e to bring the M = 5 results into better agreement with the more reliable M = 26 results of Norcross and Stone. However, in the absence of such a comparison it does not appear that construction of accurate but simple atomic models is a straightforward process. (auth)

43870 DEPARTURE FROM LTE IN THE THERMIONIC CONVERTER. Norcross, D. W. (Sperry Rand Research Center, Sudbury, Mass.). pp 332-40 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

Reported electron temperature and density profiles across the interelectrode space of a thermionic converter have been analyzed using a model which has been described previously. For each set of T_e and N_e points, effective coefficients for ionization and for radiative energy loss are computed. These coefficients and the neutral density (obtained through the assumption of a linear heavy-particle temperature distribution across the gap, and the ideal gas law) yield the rates for net ion production and radiative energy loss from all sources except the resonance lines. Energy loss from resonance lines and the ion production cost are considered separately. The following general conclusions can be drawn from the consistent behavior of the results: (1) the area within 0.4 mm of the emitter is a source of ion–electron pairs, the rest of the plasma being a sink; (2) inelastic energy losses decrease monotonically from the emitter to the collector; (3) these effects are relatively independent of cesium pressure, but are generally proportional to output current density. (auth)

43871 IMPROVED THEORETICAL DESCRIPTION OF THERMIONIC CONVERTER PERFORMANCE CHARACTERISTICS. Wilkins, D. R. (General Electric Co., Pleasanton, Calif.). pp 341-9 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

A previously developed theoretical description of thermionic converter operation is extended to include: (a) Schottky effects at the emitter and collector electrodes, (b) recent advances in the theoretical understanding of surface phenomena, and (c) improved analyses of the electrostatic sheaths. Quantitative comparisons between theoretical and experimental output current characteristics are presented for a wide variety of converter operating conditions, and good agreement is obtained. Schottky effects have a very significant influence upon the performance characteristics of thermionic converters for certain operating conditions of practical interest. (auth)

43872 IMPROVEMENTS IN OR RELATING TO COMPOSITE ELECTRODES. Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,085,879. Oct. 4, 1967. Priority date July 2, 1964, France.

A composite electrode for a magnetohydrodynamic generator is described which consists of a first zone of stabilized refractory oxide, such as doped zirconia or thoria, and a second zone of graphite. The face of the electrode is covered with a material having good thermionic emission. Drawings are shown which include cross sections of the electrode and an assembly of electrodes in an MHD channel. (J.H.M.)

43873 COMPOSITE ELECTRODE AND METHOD OF FABRICATION THEREOF. Devime, Robert; Yerouchalmi, David (to Commissariat a l'Energie Atomique). British Patent 1,086,009. Oct. 4, 1967. Priority date Mar. 24, 1964, France.

A composite electrode for a magnetohydrodynamic generator is described, and a method for manufacturing the electrode is discussed. The electrode consists of an assembly of segments of refractory oxides which are joined to each other by means of a joint formed of a noble or inert refractory metal. (J.H.M.)

43874 PRODUCTION OF MAGNETIC FIELDS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,084,562. Sept. 27, 1967. Priority date Jan. 22, 1964, Germany.

Design information is presented on a device for producing a magnetic field in an air gap accommodating the funnel-shaped operational channel of an MHD transducer. (J.H.M.)

Fluid Physics

Refer also to abstracts 43186, 43552, 43848, and 43858.

43875 (AD-651670) NONIDEAL MGD FLOWS IN BOUNDARY LAYER APPROXIMATION. Friedel, Helmut (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Mar. 5, 1967. Contract F61052-67-C-0014. 25p. (AFOSR-67-0992). CFSTI.

In a two-dimensional magnetic boundary layer approximation, MGD basic equations are used for treating certain classes of slender nozzle flows. By a two-parameter similarity transformation the general boundary layer equations are transformed into a system of ordinary differential equations, which can be solved analytically for a certain parameter combination. Also, the general solution of the ideal MGD boundary layer equations is given in a closed form. These classes of formal solutions are used for studying various flows through diverging and converging nozzles and free plasma mets confined by magnetic fields. (auth) (TAB)

43876 (NP-17033) MAGNETOHYDRODYNAMIC EFFECTS UPON HEAT TRANSFER IN CHANNEL ENTRANCE FLOWS OF FLUIDS WITH LOW PRANDTL NUMBERS. Tan, C. W. (Grumman Aircraft Engineering Corp., Bethpage, N. Y. Research Dept.). Mar. 1965. 22p. (RE-206J).

Heat transfer is studied in fluids with low Prandtl numbers under a transverse magnetic field at the thermal entrance region of a parallel-plate channel with constant wall temperature using the energy-integral method. Both laminar and turbulent flows are treated. A heat transfer parameter measuring the magnetic, electric, and thermal fields is introduced. Increasing the heat transfer parameter is found to increase the fluid temperature more in the core region than near the walls. Thermal boundary-layer development and the heat transfer rate are presented for the thermal entrance region of the channel. Comparison of the present analysis with results obtained by other investigators shows good agreement in the limiting case of fully developed liquid metal flows. (auth)

43877 UNSTABLE CONDUCTING FLUID FLOW IN A MAGNETIC FIELD UNDER CONSTANT GRADIENT PRESSURE. Ryabinin, A. G. Teplofiz. Vys. Temp., 5: 726-9(July-Aug. 1967). (In Russian).

Magnetohydrodynamic equations were developed for the case of unstable fluid flow under constant pressure gradient, in a plane finite-width channel, with the perfectly insulating walls perpendicular to the external magnetic field and two perfectly conducting side walls, short circuited to the external load. (R.V.J.)

43878 BOUNDARY LAYER OF THE NON-CONDUCTING MAGNETOGASDYNAMIC CHANNEL WALL. Benenson, E. B.; Genkin, A. L. Teplofiz. Vys. Temp., 5: 624-9(July-Aug. 1967). (In Russian).

A laminar boundary layer of compressed conducting gas on a nonconducting surface in a magnetogasdynamic channel was investigated. A solution was obtained for the non-auto model problem. Calculated data on the temperature, rate, electric current density in the boundary layer, and heat-transfer were correlated with the magnitudes in the boundary layer of the conducting surface. (tr-auth)

43879 RADIO-FREQUENCY CONDUCTIVITY OF IONIZED GASES IN MAGNETIC FIELD. Gupta, R. N.; Mandal, S. K. (North Bengal Univ., India). Indian J. Phys., 41: 251-9(Apr. 1967).

The radio-frequency conductivity of ionized gases (air and carbon dioxide) has been measured within a pressure range of a few microns of Hg to 0.3 mm of Hg in presence of a magnetic field varying from 0 to 700 gauss, and a frequency of 10.6 Mc, the discharge being excited by a transformer. It has been observed that conductivity decreases in presence of magnetic field for all values of pressure and the pressure at which the conductivity becomes a maximum increases with the increase of magnetic field. The results can be explained fairly well by an extension of the theory put forward by Gilardini (1959) and the quantitative agreement is also satisfactory. The introduction of the effect of equivalent pressure generally gives results in wide divergence with experimental results and hence it is concluded that for values of (H/P) employed in this case, the equivalent pressure concept does not hold. The reasons for the failure of equivalent pressure expression in this case have been discussed. (auth)

43880 MAGNETOHYDRODYNAMICS OF ROTATING FLUIDS. Schwiderski, Ernst W.; Lugt, Hans J. (Naval Weapons Lab., Dahlgren, Va.). J. Appl. Mech., 34: 563-70(Sept. 1967).

The influence of rather general electromagnetic forces acting upon steady rotating motions of conducting viscous incompressible fluids over a rotating disk is investigated by means of adjustable local boundary-layer approximations of first order. Numerical results for the most important motions of von Kármán and Bödewadt are displayed and discussed in full detail. The hypothesis of small variations of the imposed magnetic field assumed in other investigations is found to be justified provided the corresponding Hartmann number and magnetic Reynolds number are of sufficiently small magnitude. Considerable distortions of the rotating motions result from strong electromagnetic forces. When the strength of the imposed electromagnetic forces is increased, the secondary motions may change their stagnation character to wake character, and vice versa. This change may proceed through the development of one-cell and two-cell flows as intermediate stages. The spatial instability of wake-type flows can be decreased or increased depending on the strength and the direction of the applied electromagnetic forces. In addition to critical Reynolds numbers, critical Hartmann numbers and magnetic Reynolds numbers are shown to exist beyond which no simple boundary-layer-type motions are possible. The interpretation of the spatial instability of wake-type flows as a separation phenomenon is supported by the "teacup" experiment photographed. (auth)

43881 MAGNETOHYDRODYNAMIC STAGNATION-POINT FLOW IN A PURELY AZIMUTHAL MAGNETIC FIELD. Reznikov, B. I.; Smyslov, Yu. N. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 3-8(July-Aug. 1967). (In Russian).

Axisymmetric magnetohydrodynamic stagnation-point flow was studied in the presence of a purely azimuthal nonhomogeneous magnetic field $B\{0,B_\theta,0\}$. The problem is related to MHD problems with the "layer-type" solutions, including the classical Navier–Stokes solutions. Numerical integration of equations describing MHD stagnation point flow in a wide range of Alfven and diffusion numbers was accomplished. (R.V.J.)

43882 PRECISE AND APPROXIMATE SOLUTIONS FOR NON-STATIONARY CONDUCTING FLUID FLOW IN MAGNETODYNAMIC CHANNELS. Ryabinin, A. G.; Khozhainov, A. I. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 151-4(July-Aug. 1967). (In Russian).

Simplified equations are developed for nonsteady high-conductivity fluid flow in plane MHD channels with external electric circuits. It was observed that in homogeneous electric field channels nonsteady conducting flow is aperiodic, which is the result of the complex law of the time–pressure gradient variations or the reactance of the external electric fields. (R.V.J.)

43883 DAMPING OF AN OBSTACLE WAKE IN ELECTRO-CONDUCTOR LIQUID EXPOSED TO A TRANSVERSE MAGNETIC FIELD. Causse, Rene; Crausse, Etienne (Univ. Avignon, Vaucluse, France). Compt. Rend., Ser. A and B, 264: 910-11 (May 22, 1967). (In French).

The action of a transverse magnetic field on the oscillation of an obstacle wake was studied experimentally. The R(M) curve, relative to the suppression of this oscillation, was obtained. The influence of M on the amplitude was determined. (tr-auth)

43884 SINGULARITIES OF HARTMANN LAYERS. Roberts, P. H. (Univ. of Newcastle-upon-Tyne, Eng.). Proc. Roy. Soc. (London), Ser. A, 300: 94-107(Aug. 22, 1967).

The study described is concerned with the parallel flow of conducting fluid along an insulating pipe of uniform cross section perpendicular to which a uniform magnetic field, B_0, is applied. The cross-section is supposed to have tangents parallel to B_0 only at isolated points of its perimeter. The density, kinematic viscosity and electrical conductivity of the fluid are denoted by ρ, ν, and σ, respectively. It is known (Shercliff 1962) that, in the limit $B_0 \to \infty$, the flow may be divided into three parts: (i) a Hartmann boundary layer, thickness $\sim(\rho\nu/\sigma)^{\frac{1}{2}}(B_0 \cos\theta)^{-1}$, at every point of the wall except those at which $\cos\theta = 0$, where θ is the angle between B_0 and the normal to the wall at the point concerned, (ii) a "mainstream," far from the walls, which is controlled by the Hartmann layers and in which a quasi-hydrostatic balance subsists between the Lorentz force and the applied pressure gradient driving the motion, and (iii) a complicated boundary-layer singularity, at each point of the wall at which $\cos\theta = 0$, which is controlled by the flow in regions (i) and (ii). The solutions for regions (i) and (ii) can be obtained easily by Shercliff's methods. It is proposed to elucidate region (iii). Here the boundary-layer thickness is $O(M^{-\frac{1}{2}})$ and extends round the periphery of the wall for a distance which is $O(M^{-\frac{1}{2}})$, where M is a Hartmann number, $B_0\mathscr{T}(\sigma/\rho\nu)^{\frac{1}{2}}$, based on a typical dimension, $\mathscr{T}$, of the pipe. The corresponding contribution to U, the mean flow down the duct, is of order $M^{-\frac{1}{2}}$. In fact, for a circular duct of

radius a(= $\mathscr{P}$), the main case discussed, it contributes the final term to the following expression: $U = 64/3\pi\, U_0[1/M - 3\pi/2M^2 + 3.273/M^3]$. Here U_0 is the mean flow in the absence of field. (auth) (UK)

43885 GENERALIZATION OF KAPUR-SHUKLA'S PROBLEM. Dinu, L. I. Stud. Cercet. Mat., 18: 1573-7(1966). (In Rumanian).

The unsteady flow in a transverse magnetic field of two incompressible immiscible fluids between two parallel infinite plates, the pressure gradient of which is time-variable, is considered. (auth)(Romanian Sci. Abstr.)

43886 INTERACTION OF CHARGED HIGH-ENERGY PARTICLES WITH HYDROMAGNETIC WAVES. Shabanskii, V. P. (Moscow State Univ.). Geomagn. Aeron., 6: 472-8 (1966). (In Russian).

The generation by a high-energy particle of a hydromagnetic shock wave front, propagating perpendicular to a magnetic field is discussed, on the assumption that the particle velocity is considerably greater than the wave velocity and that the wave front width is considerably smaller than the Larmor radius of the charged particle. It is shown that the magnetic moment of the particle remains constant during this process. The displacement of the instantaneous rotational center of the particle as it passes through the front is derived in an expression which is in good agreement with other results on the increase in the energy of the particle and its displacement under similar conditions. As estimate is made of the possible displacement of particles (diffusion rate) of the radiation belts of a hydromagnetic wave propagating in the magnetosphere. A characteristic feature of the diffusion considered is the fact that its velocity increases along with the magnetic moment of the particle in the field (i.e., with the energy of the particle), as opposed to diffusion caused by global changes in the geomagnetic field. (ATD)

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Refer also to abstracts 43311, 43839, 43941, and 44495.

43887 (AD-650752) THEORETICAL STUDY OF THE PROPAGATION OF INFRASONIC WAVES IN THE AIR. Final Report, January 1964-February 1967. Pierce, Allan D.; Moo, Charles A. (Avco Corp., Wilmington, Mass. Avco Missile, Space, and Electronics Group). Contract AF 19(628)-3891. 66p. (AFCRL-67-0172). CFSTI.

The theory of the propagation of long-period infrasonic waves from nuclear explosions in the atmosphere is reviewed and the extensions of the theory are described. A simple demonstration of the theoretical basis of amplitude-yield proportionality is given and work on the extension of the normal mode method to include nonstratified windy atmospheres is described. The formulation for incorporating wind effects into theoretical models is reviewed. A justification of the multilayer method is given and numerical results based on this approximation are summarized. All reports, journal articles, and symposia papers written during the investigation are listed, and an extensive bibliography on atmospheric waves and nuclear explosions is included. Recommendations for future research are given. (auth) (TAB)

43888 (AD-651017) STIMULATION OF OPTICAL EMISSIONS IN ATMOSPHERIC GASES. Final Report, December 1, 1961-December 31, 1966. Baker, Doran J. (Utah State Univ., Logan, Electro-Dynamics Labs.). Contract AF19(628)-251. 240p. (AFCRL-67-0058). CFSTI.

An investigation was made of energy exchange mechanisms among gases which result in radiative phenomena, particularly infrared. This includes research on fluorescent mechanisms such as electron, ion, and molecular inelastic collisions with molecules, and luminescent phenomena resulting from gas kinetic reactions. Basic questions of energy partition into kinetic or internal excitation of the products of a chemical reaction were pursued. The central purpose of this effort was to obtain a fundamental microscopic description of physical processes (such as cross sections) from which macroscopic properties directly applicable to Air Force problems can be predicted. The phenomena investigated represent the microscopic descriptions of flames, natural and artificially induced airglows, natural and artificially induced aurora, optical signatures of re-entry vehicles, and missile trails. (auth) (TAB)

43889 (AD-651489) FURTHER DETAILED ANALYSIS OF TELEMETRY RECORDS OBTAINED BY EXPLORER IV SATELLITE CONCERNING GEOMAGNETICALLY TRAPPED RADIATION. Final Report, November 1, 1965-November 30, 1966. Weber, A. H. (Saint Louis Univ., Mo. Dept. of Physics). Contract DA-49-146-XZ-494. 118p. (DASA-1889). CFSTI.

A summary is presented of five theses and dissertations completed during the contract year. The titles of these theses and dissertations are: Van Allen radiation belt and Argus directional flux density distributions, Explorer 4 satellite data, by Donald J. Manson; Van Allen belt and Argus directional flux density distributions, Explorer 4 satellite data, Argus event 2, by Joseph F. Fennell; Omnidirectional fluxes, Explorer 4 satellite data, Argus events 1 and 2, by John A. George; Omnidirectional flux densities of geomagnetically trapped radiation, Explorer 4 pre-Argus Times, by Joseph R. Ockersz; and Interpretation of directional flux densities in Argus shells, Explorer 4 satellite data, by Joseph M. Paikeday. (TAB)

43890 (AD-651815) MONTE CARLO STUDIES OF LIGHT TRANSPORT. Interim Report No. 2, September 1, 1966-January 31, 1967. Collins, D. G.; Cunningham, K.; Wells, M. B. (Radiation Research Associates, Inc., Fort Worth, Tex.). Feb. 28, 1967. Contract DA-28-043-AMC-00240(E). 77p. (RRA-T-74; ECOM-00240-2). CFSTI.

Methods were formulated for treating water vapor and CO_2 absorption in the wave length interval from 0.3 to 4 microns. These methods were incorporated into a modified version of the LITE-1 code now designated as LITE-III. In addition, LITE-III was coded to allow for biased sampling of path lengths and to print the angular distributions of the scattered intensities and currents as a function of ground albedo for three separate reference planes at each receiver position. A literature search was conducted to gather the information necessary to generate cross section data as a function of wave length and altitude for all of the significant interactions undergone by light in the atmosphere for wave lengths in the range from 0.3 to 4 microns. The scattering and absorption cross section data obtained from the literature search were used to prepare library input data for the five model atmospheres to be considered in LITE-III calculations of the atmospheric transmission of the thermal radiation emitted by nuclear weapon. A study was conducted to analyze the angular distribution of the scattered intensity of 0.55 micron light transmitted through an Elterman atmosphere. (auth) (TAB)

43891 (AD-651937) IONOSPHERIC MOTION AND INTERNAL GRAVITY WAVES. Bugnolo, Dimitri S. (Columbia Univ., Dobbs Ferry, N. Y. Hudson Labs.). Jan. 16, 1967. Contract Nonr-266(84). 39p. (TR-132). CFSTI.

A first order theory is developed to describe the motions of electrons and ions in a weakly ionized gas in the presence of a magnetic field, when the gas is disturbed by the passage of a low-frequency wave such as an internal gravity wave. The approximations used are believed to be compatible to the case of an internal gravity wave in the lower ionosphere. An illustrative example of the normal ionosphere at the 90 km level over Dobbs Ferry, New York, is used to emphasize the complexity of the problems involved. (auth) (TAB)

43892 (N-67-21425) USE OF THE LANGMUIR PROBE TO DETERMINE THE ELECTRON DENSITY AND TEMPERATURE SURROUNDING RE-ENTRY VEHICLES. Final Report. Scharfman, W. E.; Bredfeldt, H. R. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1966. Contract NAS1-4872. 102p. (NASA-CR-66275). CFSTI.

The operation of a probe consisting of an electrode wire supported by a wedge-shaped dielectric structure, designed to fly on board the Langley Research Center RAM-C vehicle, was checked by comparison with wire probes and microwave interferometers in an arc-driven shock tube. Measurements were performed over a wide range of electron densities and at initial shock-tube pressures of 0.1 and 1.0 torr. The effect of yaw angle of up to 15° was also checked. The measurements showed that the RAM-C probe could be interpreted in the same manner as a cylindrical-wire probe. A theory was developed for a wedge-shaped electrode structure for operation for which the structure is large compared to the mean-free path. Electron temperature was measured in the shock tube under conditions that were not free-molecular. Good agreement was obtained between the measured electron temperatures and the gas temperature. An experiment was conducted to estimate how the probes would operate in an environment that includes water droplets. The electron density inferred from the probe current was compared to that measured by a microwave interferometer both before and during water-droplet injection into a seeded ethylene-oxygen flame. The relative changes in electron density, as inferred by both techniques, followed each other closely. The probe was not affected by the water droplets. (auth) (STAR)

43893 (N-67-23320) ORDERED MAGNETIC FIELD OF THE MAGNETOSHEATH. Fairfield, D. H. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard

Space Flight Center). Apr. 1967. 38p. (NASA-TM-X-55750; X-612-67-174). CFSTI.

Simultaneous data from the IMP 1 and IMP 2 satellites revealed that magnetic field discontinuities seen at one satellite are subsequently seen at the other with delay times consistent with the idea of magnetic fields frozen in the solar wind being convected away from the Sun with the solar wind velocity. A one to one correspondence of discontinuities at the two satellites persists even when one satellite is in the magnetosheath, showing that interplanetary fields are convected into the magnetosheath. Analysis of the directional distribution of magnetosheath fields and their relation to simultaneously measured interplanetary fields shows that as the magnetosheath fields are convected around the magnetopause by the solar plasma they undergo distortion from their interplanetary values until they are aligned tangent to the magnetopause. A hydromagnetic interpretation is that interplanetary field lines, after being convected through the Earth's bow shock, become draped around the magnetosphere with the sense of the magnetosheath field being that of the incoming interplanetary field. (auth) (STAR)

43894 (N-67-23326) PROTON-ELECTRON SPECTROMETER EXPERIMENTS ON GEMINI-4 AND GEMINI-7. Final Report, May 27, 1963-September 30, 1966. Reagan, J. B.; Bakke, J. C.; Heinemann, M. A.; Imhof, W. L.; Smith, R. V. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). Contract NAS9-1587. 94p. (NASA-CR-65604; LMSC-2-44-66-1). CFSTI.

Two experiments are described which were performed aboard the Gemini-4 and Gemini-7 spacecraft to measure the external radiation environment. Omnidirectional fluxes and spectra of electrons in the 0.5 to 8.0-MeV energy range and of protons in the 25 to 80 MeV energy range as well as the omnidirectional proton flux greater than approximately 80 MeV were measured by scintillation spectrometers employing 16-channel pulse-height analyzers. A detailed description of the spectrometers including design philosophy, laboratory and in-flight calibration, and flight performance is included. Preliminary results from the experiments in the form of proton and electron flux contours and spectral shapes in B,L space are given. A comparison between the present data and previous experimental and theoretical results is also included. Proposed additional detailed data analysis is suggested. (auth) (STAR)

43895 MEASUREMENT OF WEAK MAGNETIC FIELDS BY MAGNETIC RESONANCE. Grivet, P. A. (Univ. of Paris, Orsay, France); Malnar, L. Advan. Electron. Electron Phys., 23: 39-151(1967).

A summary of the magnitude and main characteristics of natural magnetic fields (geomagnetic and interplanetary fields) is followed by a review of measurement methods based on magnetic resonance. The techniques of double irradiation and optical pumping are emphasized. A cesium vapor magnetometer is described to illustrate the practical problems encountered in designing optically pumped magnetometers. The principle involved in use of superconducting interferometers as magnetometers is presented, and a laboratory prototype called SQUID (Superconducting Quantum Interference Device) is described. 187 references. (A.G.W.)

43896 THE CALCULATION OF DOPPLER SHIFTS DUE TO A CHANGING IONOSPHERE. Bennett, J. A. (Univ. of Melbourne). J. Atmos. Terrest. Phys., 29: 887-92(July 1967).

It is shown, by making use of Fermat's principle, that the Doppler shift experienced by radio waves propagating through a slowly varying ionosphere in which collisions are neglected, is given by $\delta f = -f/c \int (\partial\mu/\partial t) \cos\alpha \, ds$, provided the ray path satisfies a number of additional requirements usually met in practice. The effect of ionospheric resonances and reflections is considered to give a careful statement of the range of application of the result. (auth) (UK)

43897 DIVERGENCE OF RADIO RAYS IN THE IONOSPHERIC MEDIUM. Heisler, L. H.; Nelson, G. J. (Commonwealth Scientific and Industrial Research Organization, Chippendale, New South Wales. Univ., of Sydney). J. Atmos. Terrest. Phys., 29: 839-55(July 1967).

Recently developed ray tracing computer techniques have permitted a more detailed investigation of the divergence of radio rays in the ionosphere. The extent of this divergence for hypothetical ionospheric models is discussed with emphasis on limitations imposed by its neglect in ionospheric analysis. Estimation of actual spatial separation of ordinary and extraordinary ray reflection points has enabled reassessment of earlier data, providing valuable information on slopes of effective wave fronts and general features of traveling ionospheric disturbances. (auth) (UK)

43898 MAGNETIC FIELD-ALIGNED IRREGULARITIES AT MID-GEOMAGNETIC LATITUDES. Dyson, P. L. (Univ. of Melbourne). J. Atmos. Terrest. Phys., 29: 857-69(July 1967).

The conditions are examined under which radio waves may be trapped and guided along magnetic field lines by irregularities in electron density. From the analysis of topside ionograms recorded by the Alouette I satellite, it has been found that field-aligned irregularities can exist in the form of sheets which may be up to 30 km in extent in the E-W direction. The results of ray tracing using simple models for irregularities are also presented. (auth) (UK)

43899 SOME AIRBORNE NIGHT AIRGLOW O I LATITUDE OBSERVATIONS. Markham, Thomas P. (Air Force Cambridge Research Labs., Bedford, Mass.); Anctil, Robert E. J. Atmos. Terrest. Phys., 29: 897-901(July 1967).

Night airglow O I latitude observations from a high-speed jet aircraft made during IQSY are compared with similar shipboard observations made during IGY. (auth) (UK)

43900 WAVE PROPAGATION IN A RANDOM MEDIUM WITH PARABOLIC BACKGROUND. Liu, C. H. (Univ. of Illinois, Urbana). Radio Sci., 2: 961-77(Sept. 1967).

Wave propagation in a random medium with inhomogeneous background is studied. The medium is assumed to be characterized by a dielectric permittivity $\epsilon_0(x) + \epsilon_1(x)$ where $\epsilon_0(x)$ is a function of space and $\epsilon_1(x)$ is a random function of position. With ionospheric propagation application in mind, the background medium is taken as an inhomogeneous plasma region with electron density varying as a function of z. A slab of random irregularities is assumed to be imbedded in the plasma. Fluctuations and correlation functions of spherical waves propagating through this medium are calculated using W.K.B. and perturbation techniques. They are compared with the results obtained for the case where the background medium is homogeneous. It is found that the corrections to the fluctuations due to the inhomogeneous background are maximum when the irregularity slab is at the peak of the electron density profile. From this result, it is believed that scintillations of radio signals from satellites are more easily observable when the irregularities are near the peak of the ionosphere electron density profile. (auth)

43901 TRANSMISSION OF ULTRASHORT COHERENT PULSES THROUGH THE IONOSPHERE. Bramley, A. (Bramley Consultants, Falls Church, Va.). Electron. Lett., 3: 266(June 1967).

A study is made of scattering and absorption of ultrashort coherent radiation pulses when they pass through an electron gas, such as occurs in the ionized upper layers of the atmosphere. (auth) (UK)

43902 SMALL-SCALE SPATIAL FLUCTUATIONS OF A V.L.F. WAVE FIELD IN THE IONOSPHERE IN THE ZONE CLOSE TO THE TRANSMITTER. Aubry, M. P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Electron. Lett., 3: 298(July 1967).

The FR-1 satellite experiment, the characteristics of which have been described in a previous paper by Storey, has provided information on the penetration of upgoing vlf waves in the ionosphere. The experiment involves a transmitter located at Sainte-Assise (France), radiating 20 kW on 16.8 kHz, and a receiver aboard the satellite at 750 km altitude. An account of the first results concerning the mean level, and also the large- and small-scale spatial fluctuations of the vlf field, has been published already by the author. In the present communication the problem of the spatial fluctuations of the vlf field on the small scale (less than 100 km) is more carefully analysed. (auth) (UK)

43903 PLASMA RESONANCES OF THE MAGNETOSPHERE. Mainstone, J. S. (Cambridge Univ., Eng.). Nature (London), 215: 1048-50(Sept. 2, 1967).

Theoretical attempts have been made to determine possible hydromagnetic resonances of the magnetosphere which should be excited by the solar wind. Under conditions of axial symmetry it is possible to obtain uncoupled solutions for poloidal and toroidal modes. Calculations from magnetosphere models for these modes indicated that the eigen periods should lie in the geomagnetic micropulsation range. In practice there are considerable departures from axial symmetry in the magnetosphere, and the question arises whether it is possible to observe anything approximating to axially symmetric resonant modes. Daily micropulsation spectra in the form of sonograms covering the Pc3 to Pc4 range have been obtained at a number of stations, and careful examination of these provides strong evidence in favour of the existence of hydromagnetic resonances associated with axially symmetric modes, in addition to other resonances which probably are not axially symmetric. Examples of these sonograms are reproduced and dis-

cussed. Advantages of the sonogram method of dynamic spectrum presentation lie in the optical integration inherent with this type of display, making recongnition of invariant features relatively simple. "E to W morning enhancement" has also been observed by other authors. At times of great geomagnetic agitation the micropulsation spectrum can become very complex. (UK)

43904 LUNAR IONOSPHERIC WINDS DEDUCED FROM THE DYNAMO THEORY OF GEOMAGNETIC VARIATIONS. Maeda, H.; Fujiwara, M. (Kyoto Univ.). J. Atmos. Terrest. Phys., 29: 917-36(Aug. 1967).

Ionospheric winds required to produce the lunar daily geomagnetic variations are deduced from the atmospheric dynamo theory that takes into account the electric linkage between conjugate points in the northern and southern hemispheres. The electrical conductivity of the ionosphere is first estimated on the basis of atmospheric and ionospheric models for a moderate state of solar activity, and wind systems are then calculated separately for two supposed current layers (thick and thin) and also for three different seasons (D, E and J months). It is found that the amplitudes of wind velocities in middle latitudes are about 10 m/sec for the thick layer and about 15 m/sec for the thin layer, and that the phases are such that the wind systems have two sources around 9 hr and 21 hr and two sinks around 3 hr and 15 hr in lunar time. There is a tendency for the amplitudes of winds to be a little larger in winter than in summer, and the phases are advanced systematically from summer to winter. The results are discussed by comparing with other theoretical and observational results, and suggest a purely tidal origin of the lunar daily geomagnetic variations. (auth)

43905 COLLISIONAL PITCH REDISTRIBUTION AND THE SPECTRA OF EMERGENT ELECTRONS. Catchpoole, J. R. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys., 29: 949-55(Aug. 1967).

An earlier determination of the photoelectric contribution to the magnetospheric electron density is reviewed on the basis of an opposing assumption concerning the pitch redistribution of the collision component. It is found that the resultant total emergent spectra are of the same order for either model, being primarily determined by the collision-free component. Significant changes are found, however, for individual energy ranges in the pitch angle distributions of the emergent flux which, for specified parameters, tend to be appreciably more isotropic for the new model considered. This is attributable to a greater transmission of electrons at both extremes of pitch angle. A few remarks are made concerning an analysis of the heights within the atmosphere from which originate particular components (both energy and pitch) of the emergent spectra. (auth) (UK)

43906 PROPAGATION OF elf RADIO WAVES TO GREAT DISTANCES BELOW THE ANISOTROPIC IONOSPHERE. Yamashita, Michiko (Nagoya Univ., Japan). J. Atmos. Terrest. Phys., 29: 937-48(Aug. 1967).

The propagation characteristics of elf electromagnetic waves are investigated assuming a perfectly conducting Earth and a sharply bounded homogeneous ionosphere on which a uniform and radial earth's magnetic field is superposed. An attempt was made to compare the observational results of the slow tail waveforms with the theoretical results of propagation characteristics in two cases, i.e., with and without a superposed magnetic field. It was found desirable to take the magnetic field into consideration. (auth) (UK)

43907 LARGE TRAVELING IONOSPHERIC DISTURBANCES OBSERVED AT MIDLATITUDES UTILIZING THE HIGH-RESOLUTION hf BACKSCATTER TECHNIQUE. Hunsucker, R. D.; Tveten, L. H. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.). J. Atmos. Terrest. Phys., 29: 909-16(Aug. 1967).

During the period November 21 through December 12, 1963, large traveling ionospheric disturbances (TIDs) were observed on ground-scatter records obtained with the ITSA/ESSA high-resolution azimuth-scan backscatter system at a frequency of 17.6 MHz. Simultaneous auroral zone data from College, Alaska, indicate that over half of the TIDs observed from Boulder traveling toward the southeast were preceded by auroral zone disturbances. Horizontal propagation velocities deduced from the TID observations are consistent with predicted velocities for imperfectly ducted internal gravity waves at F-region heights. It is suggested that auroral zone perturbations are a possible generating mechanism for atmospheric gravity waves which then propagate in a southeasterly direction over great circle paths exceeding 5000 km and are manifested as large TIDs observed by the Boulder scan-backscatter sounder. (auth) (UK)

43908 THE REMARKABLE SUDDEN COMMENCEMENT OF NOVEMBER 13, 1960 IN THE LOW- AND MIDDLE-LATITUDE MAGNETOGRAMS. Bhargava, B. N.; Natarajan, R. (Colaba Observatory, Bombay). J. Atmos. Terrest. Phys., 29: 957-63 (Aug. 1967).

The remarkable terrestrial magnetic impulse of November 13, 1960 has not been identified as a sudden commencement by a majority of observatories. From a consideration of principal features of the cosmic-ray flare of November 12 it is suggested that this flare was responsible for the SC of November 13, of an unprecedented magnitude, and for the magnetic storm of moderate main phase. (auth) (UK)

43909 DISCUSSION OF PAPER BY F. L. SCARF, "EFFECT OF COHERENT DENSITY FLUCTUATIONS ON THE RADAR DETERMINATION OF TOTAL ELECTRON CONTENT". Hagfors, Tor (Massachusetts Inst. of Tech., Lexington). J. Geophys. Res., 72: 4595-8(Sept. 1, 1967).

Radar experiments were reported [Howard et al. (1965) and Yoh et al. (1966)] in which group and phase delay introduced by the cislunar medium were interpreted in terms of a mean plasma electron concentration. Electron concentrations found by these techniques appear to be very much higher than those derived by other means, such as whistlers, from micropulsations, or on theoretical grounds. Scarf (1966) attempted to explain the discrepancy as an effect of coherent density fluctuation on the mean propagation constants of the plasma. It is suggested that the effect discussed by Scarf is probably unimportant and hence that some other explanation of the discrepancy between the results of the radar propagation experiments and the currently accepted model of the magnetospheric tail must be sought. (J.H.M.)

43910 HYDROMAGNETIC PROPAGATION IN A THETA-MODEL GEOMAGNETIC TAIL. McClay, John F. (Air Force Cambridge Research Labs., Bedford, Mass.); Radoski, Henry R. J. Geophys. Res., 72: 4525-8(Sept. 1, 1967).

The geomagnetic tail is represented by a cylinder with a central plane (the neutral sheet) dividing it into two regions containing antiparallel magnetic fields. Thus, in cross section, it resembles the letter theta. The equations for the two possible hydromagnetic modes, the transverse magnetic and the transverse electric, are derived. The effect of the parallel electric field is retained to obtain a complete description of the transverse magnetic mode. The solutions for these modes are presented, and the associated eigenperiods are calculated assuming perfectly reflecting boundaries. (auth)

43911 QUIET AND DISTURBED STRUCTURE AND VARIATIONS OF THE NIGHTTIME E REGION. Wakai, Noboru (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 72: 4507-17(Sept. 1, 1967).

The maximum electron concentration of the nighttime E region, the valley above it, and the appearance of the intermediate layer are described in detail from analyses of the low-frequency ionograms (50 to 2000 kHz) obtained at Boulder for three nights of quiet, moderate, and severe geomagnetic activity. Electron concentration profiles are obtained from the ionograms by a method giving some information about the width and depth of valley minimums in the nighttime E region. These parameters are obtained by analysis of parts of the ordinary and extraordinary radio echo traces, and then cross-checked by a ray-tracing process from which the complete ordinary and extraordinary ray curves (including the extraordinary ray below the gyrofrequency) are calculated for comparison. The profiles consistently show a deep, wide valley on magnetically quiet nights, and are filled in with increasing ionization as magnetic disturbance becomes more severe. An intermediate layer develops during strong disturbances. The latitude variation of nocturnal ionization in the intermediate region is shown. Possible causes of the nighttime E region are discussed in connection with the results obtained. (auth)

43912 SPACE AND TIME VARIATIONS IN OUTER-BELT ELECTRON SPECTRA. Paolini, F. R.; Theodoridis, G. C.; Frankenthal, S. (American Science and Engineering, Cambridge, Mass.). J. Geophys. Res., 72: 4590-4(Sept. 1, 1967).

Observations are reported of variations in the spatial dependence of the spectra of outer-belt electrons, which are associated with geomagnetic activity. The data were obtained between July 3 and August 31, 1963, from a scintillation spectrometer on Hitch-Hiker 1. (J.H.M.)

43913 AURORAL-ZONE X-RAY BURSTS OF 5- TO 25-MILLISECOND DURATION. Parks, G. K.; Milton, D. W.; Anderson, K. A. (Univ. of California, Berkeley). J. Geophys. Res., 72: 4587-9(Sept. 1, 1967).

Auroral-zone balloon measurements of bursts of energetic electrons having a duration of 5 to 25 msec are reported. The apparatus employed consisted of two scintillation detectors having different physical collimation of x-ray fluxes. The results are

consistent with measurements of energetic electron fluxes by rocket-borne detectors during auroral breakups. (J.H.M.)

43914 THE GEOMETRY OF THE MAGNETOSPHERE. Wentworth, R. C. J. Geophys. Res., 72: 4582-6 (Sept. 1, 1967).

An explanation is presented for the open, split-tail topology of the magnetosphere. Consideration is given to forces of interaction between the solar wind and geomagnetic field and certain aspects of the magnetospheric tail that should be observed in the future. (J.H.M.)

43915 LONGITUDE DEPENDENCE OF GEOMAGNETICALLY TRAPPED ELECTRONS. Roederer, Juan G. (Goddard Space Flight Center, Md.); Welch, Jasper A.; Herod, James V. J. Geophys. Res., 72: 4431-47 (Sept. 1, 1967).

A general Fokker–Planck equation is deduced, which describes the distribution of geomagnetically trapped electrons as a function of longitude, time, energy, and mirror point field intensity. A special variable for the longitudinal position of a particle is introduced. The coefficients representing longitudinal drift, ionization loss, and multiple Coulomb scattering are derived. The physical interpretation of this equation is analyzed for several special cases. The equation is integrated numerically for a stationary case, for low L shells. The eigenmode electron distribution function for the longitude-dependent problem is determined, and electron fluxes, energy spectra, B dependence, and mirror point trajectories are calculated for the area of the South American anomaly. The variation of these characteristics with local time in the anomaly is discussed. In general, results are in agreement with satellite observations. Coulomb scattering is certainly the most important pitch-angle diffusion mechanism for low L shells and can reasonably account for the observed longitude dependence of electron fluxes on B–L rings of $h_{min} \gtrsim 0$ km. It cannot, however, explain the observed replenishment at higher B values ($h_{min} < 0$ km). Presently available experimental material is not complete enough to allow more quantitative conclusions about the extra scattering mechanism. (auth)

43916 THE MORPHOLOGY OF THE IQSY AURORAL OVAL. II. AURORAL ALIGNMENTS IN AND NEAR THE AURORAL OVAL. Stringer, W. J.; Belon, A. E. (Univ. of Alaska, College). J. Geophys. Res., 72: 4423-9 (Sept. 1, 1967).

The azimuths of extended auroral features were measured on all-sky camera photographs from Barrow, Alaska (dp [dipole] 68°) and T-3 Ice Island (dp 78°) during the IQSY period 1964–1965. The arc alignments measured at Barrow during the IQSY period are parallel for all hours to the Barrow arc alignments during IGY. This suggests that auroral alignments are independent of solar cycle. The T-3 arc alignments, when plotted in polar diagram form with previous alignment data from several IGY stations show two separate alignment functions during nighttime hours. This bimodal behavior is interpreted to show that dp 78° is near the transition region between generally east–west-aligned auroral features of the statistical auroral zone and earth–sun-oriented auroral arcs and bands in the auroral cap. On the nightside region both the IQSY and IGY auroral ovals are situated near the statistical auroral zone (dp 66°), but on the dayside the IQSY auroral oval is situated very near dp 78°. For several hours near noon, when the IQSY auroral oval includes the high-latitude dayside aurora near dp 78°, the arc alignment, while generally, east–west, is best described as perpendicular to the earth–sun vector. (auth)

43917 THE MORPHOLOGY OF THE IQSY AURORAL OVAL. I. INTERPRETATION OF ISOAURORAL DIAGRAMS. Stringer, W. J.; Belon, A. E. (Univ. of Alaska, College). J. Geophys. Res., 72: 4415-21 (Sept. 1, 1967).

All-sky camera data from eight Alaskan stations were used to construct isoauroral diagrams for the IQSY period. The isoauroral diagrams describe the incidence of all auroral forms, discrete auroral forms, and homogeneous arcs as a function of dipole time and latitude along the dipole 256° meridian. The major features of these diagrams show close similarities with the IGY isoauroral diagram by Davis, indicating that the pattern of auroral behavior does not change from sunspot maximum to sunspot minimum. Earlier reports of an inner auroral zone are examined and reconciled with the data presented here. It is shown that the concept of a separate inner zone of auroras is misleading, while the auroral oval model represents quite well the gross behavior of the aurora in the auroral cap. (auth)

43918 ION COMPOSITION AND TEMPERATURE IN THE TOPSIDE IONOSPHERE. Mayr, H. G.; Brace, L. H.; Dunham, G. S. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 4391-4404 (Sept. 1, 1967).

The particle continuity equations for H^+ and O^+ and the energy continuity equation are solved simultaneously by means of a computer program. The processes included are photoionization, charge exchange, ambipolar diffusion along magnetic field lines, heat conduction, local and nonlocal heating, and heat loss from ions to neutrals. The ion composition and plasma temperature along various field lines are derived and studied by adopting electron concentration and temperature measurements from Explorer 22 (1000-km altitude, 1965 vernal equinox) as boundary conditions. The O^+–H^+ transition region at middle and low latitudes is fully described. It is found that a neutral hydrogen concentration of $2 \times 10^5/cm^3$ at 500 km is required to make the calculated electron concentration consistent with satellite measurements of electron concentration at 650 km. A latitudinal variation of the ion composition arises primarily because of the latitudinal variation of the electron temperature. The temperature gradient along field lines is found to be a function of latitude. The temperature decreases along the equatorial field line that passes through the equator at 1000 km, and it increases along midlatitude field lines. This is consistent with the equatorial trough of electron temperature evident in Explorer 22 data and thus explains to some degree the latitudinal variation of the ion composition. (auth)

43919 EVIDENCE FOR NONUNIFORMITY OF SOLAR-PROTON PRECIPITATION OVER THE POLAR CAPS. Reid, G. C.; Sauer, H. H. (Environmental Science Services Administration, Boulder, Colo.). J. Geophys. Res., 72: 4383-9 (Sept. 1, 1967).

Antarctic riometer observations of the PCA event of February 1965 are described. The cosmic-noise absorption at three locations, ranging in invariant latitude from about 68 to 82°, shows differences that can, at least in one case, be ascribed to differences in the local solar-proton fluxes. The observations are consistent with direct measurements of the solar-proton flux and spectrum made by a satellite during the same event, and it is shown that enhancements in proton flux seen by both the satellite and the riometers can be more readily interpreted as spatial variations than as purely temporal variations. Some implications are discussed from the point of view of the propagation of the protons through the interplanetary medium and the connection of the polar-cap field lines to the interplanetary magnetic field. (auth)

43920 DIURNAL INTENSITY VARIATION OF LOW-ENERGY ELECTRONS OBSERVED NEAR THE POLAR CAP. Jokipii, J. R.; l'Heureux, Jacques; Meyer, Peter (Univ. of Chicago). J. Geophys. Res., 72: 4375-82 (Sept. 1, 1967).

Measurements of the flux and energy spectrum of electrons, incident at the top of the atmosphere at Fort Churchill, Manitoba, exhibit a large daily intensity variation in the energy interval from about 10 to 225 MeV. High intensities are observed during the day, low intensities at night. No such variation is noticed at higher energies. This result is interpreted to be a consequence of the asymmetry of the geomagnetic field. It is concluded, on the basis of our interpretation, that the high electron flux observed during the day in the low-energy interval is mainly due to return albedo particles. These return albedo particles are not observed at night. The lower flux at night is interpreted as an upper limit to the flux of primary electrons of energy between about 20 and 250 MeV, which amounts to 81 ± 20 electrons/m^2 sec ster. (auth)

43921 SMALL-SCALE NONEQUILIBRIUM OF THE MAGNETOPAUSE AND ITS CONSEQUENCES. Parker, E. N. (Univ. of Chicago). J. Geophys. Res., 72: 4365-74 (Sept. 1, 1967).

The tangential motion of the solar wind along the magnetopause produces currents in the boundary layer that generate a magnetic field in the boundary layer transverse to the tangential motion. A simplified example is presented to illustrate the growth of the transverse field. The transverse field is approximately as strong as the geomagnetic field at the magnetopause. There is no evidence for sufficiently large electron and/or magnetic pressures to confine the transverse field, so the transverse layer apparently expands outward into the wind. This nonequilibrium enhances the mixing of geomagnetic lines of force with the solar wind plasma, thereby contributing to the "viscous" drag of the wind on the magnetopause. It is estimated that the effect may replenish the lines of force in the geomagnetic tail in 10^3 to 10^5 seconds. (auth)

43922 TRANSVERSE FLUCTUATIONS IN THE INTERPLANETARY MAGNETIC FIELD: A REQUISITE FOR GEOMAGNETIC VARIABILITY. Ballif, J. R.; Jones, D. E.; Coleman, P. J. Jr.; Davis, L. Jr.; Smith, E. J. J. Geophys. Res., 72: 4357-64 (Sept. 1, 1967).

For the first few months of the Mariner 4 flight, the probe–Sun–Earth angle remained small. The magnetometer data obtained during this time are analyzed to determine the relationship between properties of the interplanetary field and geomagnetic variability. It is shown that, although there is a good correlation between geomagnetic variability and the interplanetary field magnitude, there is still higher correlation between geomagnetic

variability and fluctuations of the interplanetary field in the plane normal to the Earth–Sun line. The nature of these fluctuations is illustrated for the two sudden commencement events that occurred during the period. (auth)

43923 A SELF-CONSISTENT STUDY OF THE EARTH'S RADIATION BELTS. Baker, John (Texas A and M Univ., College Station); Hurley, James. J. Geophys. Res., 72: 4351-5 (Sept. 1, 1967).

In most work on the dynamical equilibrium of the Van Allen belts it is assumed that the plasma is tenuous, i.e., one neglects second-order effects such as the magnetic field generated by the particles in the belt compared to the geomagnetic field. It would seem from the results of these calculations that this is not a good approximation and that the plasma energy/volume is comparable to the geomagnetic energy/volume. In this work the radiation belts are treated self-consistently. In particular, the question of how much plasma could be trapped in the belts if an unlimited source were present is considered. Judging from a preliminary calculation, it would seem that the Van Allen belts are saturated. (auth)

43924 INTENSE NEGATIVE BAYS INSIDE THE AURORAL ZONE. II. INDENTED POSITIVE BAY. Meng, C.-I.; Akasofu, S.-I. (Univ. of Alaska, College). J. Atmos. Terrest. Phys., 29: 1305-10(Oct. 1967).

During the polar magnetic substorm, there occurs an intense negative bay superposed on a gradual positive change both in the region well inside the auroral oval and in the region a little equatorward side of it. It is suggested that this phenomenon is an indication of large-scale change of the polar electrojet system during the substorm and that it can be understood on the basis of the simultaneous auroral motions (the auroral substorm). (auth)

43925 NON-CHAPMAN-LIKE BEHAVIOUR OF THE F1 LAYER. Kervin, Cristine (Radio and Space Research Station, Ditton Park, Eng.). J. Atmos. Terrest. Phys., 29: 1299-1304 (Oct. 1967).

A study is made of the critical frequency of the ionospheric F1-layer, using published data for northern hemisphere stations at sunspot minimum and sunspot maximum. The variation of critical frequency with latitude, magnetic disturbance, and season are studied for a constant solar zenith angle χ, given by $\cos\chi = 0.6$. The diurnal variation of critical frequency with solar zenith angle is also investigated. (auth)

43926 INSTABILITIES IN A GRADIENT OF IONIZATION AND SPORADIC E. Whitehead, J. D. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys., 29: 1285-97(Oct. 1967).

The instability of field aligned ionization irregularities in a vertical gradient of ionization under the conditions existing in E region of the ionosphere is investigated. It is concluded that, at the magnetic equator, the normal E region is unstable for irregularities of scale sizes 20 m to 6 km. In the temperate zones, the normal E region might be unstable with horizontal scale sizes 600 m to 6 km and large vertical scales, depending partly on the electric fields, but more importantly on the recombination coefficient. The normal E region in the temperate zones is not unstable to horizontal pancake-like irregularities. Pancake-like sporadic-E layers already in existence are likely to be unstable for irregularities of sizes from 20 m to 1 km. (auth)

43927 EQUATORIAL ANOMALY IN THE AUSTRALASIAN ZONE DURING SUNSPOT MINIMUM. Gibson-Wilde, B. C. (University Coll. of Townsville, North Queensland, Australia). J. Atmos. Terrest. Phys., 29: 1269-75(Oct. 1967).

A study is made of the annual and diurnal variations of the equatorial anomaly in the Australasian Zone (between longitudes 105° and 150°E) during the low sunspot year of 1964. There appears to be strong evidence that the equatorial anomaly plays an important role in the propagation of long-range vhf radio signals over trans-equatorial paths. (auth)

43928 DEVIATIVE ABSORPTION IN THE F2-LAYER. Sahs, A. K. (National Physical Lab., Delhi). J. Atmos. Terrest. Phys., 29: 1261-7(Oct. 1967).

Possible contribution of the the F2 layer to absorption of radio waves passing through it (vertically) is examined, using current information about the structure of the layer near its peak and the electronic and ionic temperatures in the region. The computations are compared with the "f_0F2 law" in cosmic radio noise absorption found by various workers in different phases of the solar cycle. Electron–ion collision frequencies commensurate with cosmic radio noise absorption measurements are found to be significantly higher than would be expected from available empirical formulae and electron temperature measured near F-layer peak. (auth)

43929 HIGH-LATITUDE TROUGH IN IONOSPHERIC ELECTRON CONTENT. Liszka, Ludwik (Kiruna Geophysical Observatory, Sweden). J. Atmos. Terrest. Phys., 29: 1243-59(Oct. 1967).

Results of 15 months observations of the ionospheric electron content made at Kiruna, Sweden are presented. Observations were made using the 40 and 41 MHz beacon of the S-66 satellite. Most of the nighttime observations, except for the summer period, show a distinct trough in the electron content. Seasonal and diurnal variations of the trough and of the electron content are studied. Also the corresponding equivalent slab thickness obtained using f_0F2 data from six Scandinavian ionosondes and geomagnetic control of the trough are investigated. Some features of the diurnal variation of electron content during the summer agree with the hypothesis of ionospheric heating by photoelectrons from the sunlit magnetic conjugate ionosphere. (auth)

43930 THE SCALE SIZE OF SCINTILLATION-PRODUCING IRREGULARITIES IN THE AURORAL IONOSPHERE. Lansinger, J. M. (Boeing Scientific Research Labs., Seattle); Fremouw, E. J. J. Atmos. Terrest. Phys., 29: 1229-42(Oct. 1967).

Measurements of the transverse scale of F-region irregularities, based on radio-star observations from College, Alaska, at frequencies of 68 and 223 MHz, are reported. Analysis by the two-frequency scintillation-ratio technique yields typical scales of 600 to 700 m for midauroral latitudes. Typical scales of 1 km are found for higher latitude irregularities. The latter show increasing scale with increasing magnetic index. Analysis by the two-frequency correlation technique produces erroneously small scales due to refraction effects. (auth)

43931 CUTOFF CONDITIONS FOR TRANSVERSE CIRCULARLY POLARIZED ELECTROMAGNETIC WAVES IN A FINITE TEMPERATURE ELECTROMAGNETOIONIC MEDIUM. Hsieh, H. C. (Univ. of Michigan, Ann Arbor). J. Atmos. Terrest. Phys., 29: 1219-28(Oct. 1967).

The dispersion relation for wave propagation in a homogeneous, electrically neutral electron gas subject to crossed static electric and magnetic fields is derived using the coupled Maxwell–Boltzmann Vlasov equations. The cutoff condition for transverse circularly polarized electromganetic waves is obtained from the derived dispersion relation. The variation of the cutoff frequency ω_0 with the static electric field E_0, magnetostatic field B_0, the electron number density N and the electron gas temperature T is discussed. For example it is shown that for a given value of B_0 and N, either a decrease of the electron gas temperature T or an increase of static electric field E_0 will cause the cutoff frequency of the left-hand circularly polarized wave to increase while the cutoff frequency of the right-hand circularly polarized wave decreases. A possible application of the theory to the study of electromagnetic-wave propagation in the region of ionospheric plasma, where both static electric and static magnetic fields are present, is indicated. (auth)

43932 AN EXPERIMENTAL INVESTIGATION OF THE FIELD ALIGNMENT OF IONOSPHERIC IRREGULARITIES. Brown, G. M.; Chapman, J. W. (University Coll. of Wales, Aberystwyth). J. Atmos. Terrest. Phys., 29: 1193-1200 (Oct. 1967).

A pulsed radio experiment has been devised to investigate whether the irregularities in the sub-peak F2 layer which give rise to the fading of radio signals reflected in this region are markedly "stretched" in the direction of the Earth's magnetic field at a temperate latitude station. A suitable spacing between receiving sites of the order of twenty wavelengths is chosen such that reflections of different frequencies may be obtained at points on a common field line. The variation with frequency and time of the correlation between all pairs of amplitude fading records, whether frequency or spatially separated, is examined. It is shown that in many cases the N–S dimension of the ground diffraction pattern is greater than that usually obtained by the closely spaced receiver method, and the observed time variations of the correlation coefficients are accounted for by changes of size of the irregularities. All conclusions suggest the absence of any evidence for field alignment of irregularities for the circumstances of this experiment. (auth)

43933 HORIZONTAL MOVEMENTS IN THE LOWER E- AND D-REGIONS. Beynon, W. J. G. (University Coll. of Wales, Aberystwyth); Goodwin, G. L. J. Atmos. Terrest. Phys., 29: 1181-92(Oct. 1967).

Recordings of signals from distant medium wave broadcasting stations were used to study drifts in the lower ionosphere. It is estimated that the measurements refer to levels of 85 to 90 km and 75 to 80 km. The results are compared with those given by other methods. (auth)

43934 PRELIMINARY OBSERVATIONS OF A GEOMAGNETOSPHERIC WAKE AT 1000 EARTH RADII. Wolfe, J. H.; Silva, R. W.; McKibbin, D. D.; Mason, R. H. (Ames Research Center, Moffett Field, Calif.). J. Geophys. Res., 72: 4577-81 (Sept. 1, 1967).

Preliminary plasma probe data from Pioneer 7 launched on August 17, 1966, indicate that anomalous solar wind behavior occurred from September 25 to October 1, 1966. A comparison of the data with available solar and geophysical records during this period indicates that these solar wind anomalies are not generally consistent with previously observed interplanetary behavior. It is argued that the results indicate the spacecraft encountered geomagnetic tail-associated phenomena at approximately 1000 earth radii. (J.H.M.)

43935 RESPONSE OF THE IONOSPHERE TO THE PASSAGE OF ACOUSTIC-GRAVITY WAVES GENERATED BY LOW-ALTITUDE NUCLEAR EXPLOSIONS. Kanellakos, Demetri P. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 72: 4559-76 (Sept. 1, 1967).

The response of the bottomside ionosphere to the passage of acoustic-gravity waves generated from a large low-altitude explosion (Housatonic) has been observed by means of vertical-incidence ionosondes. Acoustic-gravity wave disturbances propagated essentially horizontally away from the detonation point (G_0) with velocities of 610 and 362 m/sec corresponding to the first and second positive peaks of the disturbance. The disturbance was first sensed at each station at times corresponding to 765 m/sec. They were detected up to 4000 km from G_0. The geomagnetic field played an important role in the ionosphere response of these gravity waves. For those stations located north of G_0 and those south of the geomagnetic equator (group I stations) ionization first slid down the magnetic field lines; whereas, for stations south of G_0 but north of the geomagnetic equator (group II stations) ionization was first forced to move up the magnetic field lines. In both cases fluctuations in ionization density at a given height were observed. Considering the height and shape of the ionosphere, the ionization migration caused (1) the f_0F_2 peak height k_m to be lowered as much as 105 km as the disturbance reached its first positive peak overhead and the bottomside ionosphere to be flattened out for group I stations and (2) the opposite behavior for group II stations as the f_0F_2 disturbance reached its first negative peak. Ionosondes located at distances from 450 to 4000 km from G_0 observed fluctuations in electron concentration which at their first peak excursions reached from −20% (for group II stations) to +68% (for group I stations). The observed f_0F_2 fluctuations appear to fit an approximate theoretical formula especially with regard to their magnetic field direction and amplitude-period dependence. Ionosonde data following the near-surface 58 Mt explosion on October 30, 1961, at Novaya Zemlya also fit this theory. (auth)

43936 THEORY OF ION COLLECTION BY A SUPERSONIC ATMOSPHERIC SOUNDING ROCKET. Sonin, Ain A. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 72: 4547-57 (Sept. 1, 1967).

Charged-particle collection rates are derived in terms of free stream conditions for a supersonic, blunt-nosed sounding rocket with an electrode at the stagnation point. The analysis applies at altitudes below about 70 km. It is shown that when the electric field at the electrode is sufficiently high to dominate the particle collection, as is possible in practice at the higher altitudes, one obtains an expression for the collection rate that applies to a wide class of rocket geometries and is largely independent of flow effect. (auth)

43937 THE EFFECTS OF ION DRAG AND OF PLASMA FORCES ON NEUTRAL AIR WINDS IN THE F-REGION. Bramley, E. N. (Radio and Space Research Station, Ditton Park, Eng.). J. Atmos. Terrest. Phys., 29: 1317-21 (Oct. 1967).

The effects of interactions between ions and neutral particles on winds in the F region of the ionosphere are examined for a simple steady-state case in which viscosity is neglected. Forces acting on the plasma are included, and it found that electric fields are the only significant source of these. The effects of time varying forces are also considered briefly, and the wind is shown to lag behind the driving force by a time which is typically one or two hours in the mid-latitude F region. (auth)

43938 VHF RADIO AURORA: SIMULTANEOUS OBSERVATION OF AURORAL IONIZATION BY TWO SEPARATED RADARS. McDiarmid, D. R.; McNamara, A. G. (National Research Council, Ottawa, Can.). Can. J. Phys., 45: 3009-27 (Sept. 1967).

Data from a Canadian vhf radar network which operated during the IGY were analyzed to determine the aspect sensitivity of 48-MHz radio aurora. Two radars of this network simultaneously viewed a region of high-visual and radio-auroral activity. This paper is concerned with echoes which were obtained over a two-year period from auroral ionization simultaneously observed by these radars. The general properties of these simultaneous echoes were determined and are compared, where possible, with the corresponding properties of the overall set of echoes seen by each radar when looking independently at the same region. This comparison indicates that the mechanism responsible for simultaneous echoes is very probably the same as that which is responsible for the majority of radar echoes seen individually by the two radars. The spatial and temporal correlation between the simultaneous echoes and visual aurora is presented. The average aspect sensitivity of these echoes (48 MHz), which were obtained from simultaneous observations at off-perpendicular angles near 5° and near 20°, was found to be 1 dB per degree. (auth)

43939 ROCKET STUDIES OF ISOLATED IONOSPHERIC IRREGULARITIES. Mason, K. H.; Tull, E. H.; Forsyth, P. A. (Univ. of Western Ontario, London, Can.). Can. J. Phys., 45: 3065-78 (Sept. 1967).

It has been shown previously that ground-based observations of the relative phase, or direction-of-arrival, of radio signals propagated through the ionosphere from artificial satellites provide a useful extension to existing techniques for the study of ionospheric irregularities. This technique has now been extended to observations of the auroral ionosphere using small transmitters ejected from two rockets launched at Fort Churchill, Manitoba. Observations were also made on beacon signals from the Alouette I satellite as it passed over Fort Churchill and these revealed large irregularities in the F region but no similar irregularities in the E region. Nevertheless, when transmitters were placed between the E and the F regions, large E-region irregularities (1 to 2 km in diameter) having excess electron densities of the order of 2×10^{11} m^{-3} were clearly revealed. The background ionization, though not measured, was probably of about the same magnitude. These preliminary observations raise a number of questions which need further investigation. (auth)

43940 DEPENDENCE OF THE POSITION OF THE OUTER RADIATION ZONE INTENSITY MAXIMA ON ELECTRON ENERGY AND MAGNETIC ACTIVITY. McDiarmid, I. B.; Burrows, J. R. (National Research Council of Canada, Ottawa). Can. J. Phys., 45: 2873-8 (Sept. 1967).

The outer Van Allen radiation zone is characterized by an intensity maximum at values of the magnetic shell parameter L_{max} in the range 3.5 to 6 earth radii. Data from Alouette I and II along with data from other satellites have been used to determine the solar-cycle variation in L_{max} as a function of electron energy. During the period 1960–1966, when the yearly mean of the daily K_p sum varied from 25 to 14, the average value of L_{max} for energetic electrons varied from 3.5 to 4.7 e.r. No change was observed in the average L_{max} for 40-keV electrons during the period 1963–1966. The results are interpreted in terms of the diffusion theory of Tverskoi (1965) and imply a decrease in D_0, the average diffusion coefficient, of at least a factor of 10 between the years 1960 and 1966. (auth)

43941 UNIDIRECTIONAL AND OMNIDIRECTIONAL FLUX DENSITIES OF TRAPPED PARTICLES FROM EXPLORER 4 SATELLITE DATA. Manson, Donald J.; Paikeday, J. M.; Fennell, J. F.; George, J. A.; Weber, A. H. (St. Louis Univ.). 16p. (CONF-670429-19). DTIE.

From 48th Annual Meeting of American Geophysical Union, Washington, D. C.

Directional (scintillation counter) and omnidirectional (G–M counters) count rates from Explorer 4 Satellite telemetry have been analyzed to yield corresponding flux densities (J, particles $cm^{-2}sec^{-1}ster^{-1}$; J_0, particles $cm^{-2}sec^{-1}$) of both naturally and artificially (ARGUS events) injected geomagnetically trapped particles. Unidirectional flux densities perpendicular to B in the inner Van Allen belt 2.7×10^7 to 1.2×10^8 particles $cm^{-2}sec^{-1}ster^{-1}$ were observed in the region defined by $1.34 < L < 1.61$; a maximum flux density of 2.3×10^8 particles $cm^{-2}sec^{-1}ster^{-1}$ was observed 1.8 hrs after Event 1 at $L = 1.7$. The unidirectional flux densities perpendicular to B are summarized by a three-dimensional plot in B–L coordinates for $0.2 < B < 1.0$ and $1.4 < L < 2.15$. Omnidirectional flux densities due to ARGUS Event 1 are summarized by a three-dimensional plot in B–L coordinates for $0.2 < B < 0.25$ and $1.68 < L < 1.76$; omnidirectional plot in a region defined by $0.2 < B < 0.3$ and $1.27 < L < 1.5$. Flux density data from the naturally and artificially injected radiation is fitted by the function $J = KB^n$ where the average value of n for both natural and ARGUS data is about −7. (auth)

Low-Temperature Physics

Refer also to abstracts 43151, 44171, and 44467.

43942 (AD-651376) SUPERCONDUCTING DEVICES: A LITERATURE SURVEY. Goree, William S.; Edelsack, Edgar A. (Stanford Research Inst., Menlo Park, Calif.). Mar. 1967. 72p. CFSTI.

This bibliography of the literature of superconducting devices and related research covers most extensively the period from 1959 to March 1967, and contains approximately 1,000 entries representing English and foreign language publications. About 300 entries are on specific superconducting devices. Some 150 United States patents are also listed. So many references were available relating solely to superconducting magnets and computer elements that the listing of these was restricted. (TAB)

43943 (COO-1569-6) OBSERVATION OF QUANTIZED CIRCULATION IN SUPERFLUID HELIUM. Whitmore, Stephen Carr (Minnesota Univ., Minneapolis). Dec. 1966. Contract AT(11-1)-1569. 159p. Dep. CFSTI.

Thesis.

Circulation of the superfluid component of liquid He II around a fine wire was measured by means of the influence that the circulation exerts on the transverse vibrations of the wire. The work is a repetition and extension of an experiment performed earlier by Vinen. It gives new evidence in support of the Onsager-Feynman hypothesis that circulation of superfluid helium is quantized in units of h/m, where h is Planck's constant and m is the mass of the helium atom. (W.D.M.)

43944 (COO-1569-14) ION TRAPPING IN ROTATING SUPERFLUID LIQUID HELIUM UNDER PRESSURE. Pratt, William Porter Jr. (Minnesota Univ., Minneapolis). Dec. 1967. Contract AT(11-1)-1569. 148p. Dep. CFSTI.

Thesis.

Measurements of the lifetime of negative ions trapped in rotating superfluid liquid helium were made in the range 10 to 1000 seconds as a function of temperature and applied electric field at the saturated vapor pressure of the liquid. Measurements of the lifetime of trapped negative ions were also made in the range 20 to 400 seconds as a function of temperature and pressure from the vaporization pressure to the solidification pressure of liquid helium. (W.D.M.)

43945 (COO-1569-15) EXPERIMENTAL AND THEORETICAL STUDIES IN SOLID STATE AND LOW TEMPERATURE PHYSICS. Annual Progress Report for 1967. (Minnesota Univ., Minneapolis. School of Physics). Sept. 1967. Contract AT(11-1)-1569. 24p. Dep. CFSTI.

SUPERCONDUCTORS — currents in Josephson Junctions, studies, (E)
CRYSTALS — theory of quantum, developments in
HELIUM — phonon properties of crystalline bcc, (T)
HELIUM ISOTOPES He-3 — energy level of solid, theory of ground state; nuclear spin system of crystalline, exchange and relaxation of, (T)
PHONONS — theory of self-consistent
HELIUM ISOTOPES He-3 — He-3 - He-4, phase separation in liquid and crystalline, calculations
MANGANESE — Mn - Sb, nuclear spin resonance studies, (E)
NUCLEAR MAGNETIC RESONANCE — studies in magnetic materials, (E)
CRYOSTATS — description of adiabatic demagnetization
HELIUM — ion trapping in rotating liquid II, (E); superfluidity circulation quantization in, (E); superfluid flow in porous media, (E); transition in liquid, critical indices and Green functions of lambda, (T)
REFRIGERATION — description of helium-3 - helium-4 dilution refrigerator (D.L.C.)

43946 (ORNL-4150, pp 119-47) MAGNETICS AND SUPERCONDUCTIVITY. (Oak Ridge National Lab., Tenn.).

For several new plasma physics research facilities, extensive work on magnetic-field calculations and coil designs is being done. Several of these projects concern the production of B_{min} fields. For example, a design with water-cooled windings has been made for the INTEREM facility. For the IMP project a superconducting magnet system (consisting of two mirror coils and two different pairs of coils generating a quadrupole field) will be used. Difficult engineering problems must be solved in various fields (for instance, applied superconductivity, cryogenics, mechanical engineering, and vacuum technique). A sound theoretical base was developed for optimizing non-axially-symmetrical magnet systems with large winding cross sections. This computation method is very general and can be applied to the volume optimization of superconducting magnet systems and to the power optimization of conventional systems. A new technique for the construction of helium-vapor-cooled current leads has been developed. Tests with currents up to 1300 A proved the high efficiency of this design for introducing currents in cryogenic systems. The magnetic properties of a great number of metal alloys were measured at liquid-helium temperature. The motivation was to determine the suitability of these alloys for structural use in magnet systems, where a sizable field disturbance by the mechanical structure must be avoided. The development of InAs and InSb micro Hall probes for magnetic flux scanning at low temperatures has been continued, and significant progress has been achieved. Recent experiments in superconductivity were concerned mostly with the physics of flux flow phenomena in superconductors of the second kind. These basic investigations are of great interest for elucidating the intricate stability problems of superconducting windings. (auth)

43947 SUPERCONDUCTING MAGNET TECHNOLOGY. Laverick, Charles (Argonne National Lab., Ill.). Advan. Electron. Electron Phys., 23: 385-474(1967).

After a summary of the basic concepts of superconductivity, the present state of superconducting magnet design and development is surveyed under the following headings: magnet materials and conductors, recent significant magnets, design problems, magnet economics and large magnet studies, test facilities and instrumentation, coil fabrication facilities, and future developments. (A.G.W.)

43948 TYPE II SUPERCONDUCTORS. Lynton, E. A.; McLean, W. L. (Rutgers-The State Univ., New Brunswick, N. J.). Advan. Electron. Electron Phys., 23: 1-37(1967).

Fundamental theoretical research on type-II superconductors during the past few years is reviewed. Specific aspects considered include the London equation, quantization of flux, the Ginzburg-Landau equations, the interphase surface energy, surface superconductivity, static properties of the mixed state, and dynamic effects. (66 references) (A.G.W.)

43949 POSITIVE ISOTOPE EFFECT ON THE SUPERCONDUCTING TRANSITION TEMPERATURE OF α-URANIUM. Fowler, R. D.; Lindsay, J. D. G.; White, R. W.; Hill, H. H.; Matthias, B. T. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett., 19: 892-5(Oct. 16, 1967). (LADC-8962).

A positive isotope effect in superconductors was discovered. The relation between the transition temperatures of ^{235}U and ^{238}U can be described by $T \sim M^2$. (auth)

43950 LINEAR CURRENT-VOLTAGE CHARACTERISTICS IN TYPE-II SUPERCONDUCTORS UNDER CONDITIONS OF FLUX FLOW. Joiner, W. C. H. (Univ. of Cincinnati). Phys. Rev. Lett., 19: 895-7(Oct. 16, 1967).

The recent suggestion that the flux-flow current-voltage characteristics of type-II superconductors can be described by the relation in $I \propto V^{1/3}$ is shown to be inadequate over an extended range of currents. The previously reported linear relationship between I and V is found to hold and the present ideas about flux flow remain unchallenged. (auth)

43951 SUPERHEATING IN CYLINDERS OF PURE SUPERCONDUCTING TIN. Doll, R.; Graf, P. (Kommission fuer Tieftemperaturforschung, Munich). Phys. Rev. Lett., 19: 897-9 (Oct. 16, 1967).

Magnetization measurements were carried out on cylindrical samples of pure tin with diameters of 7, 10, and 122 μm and very clean and smooth surfaces in the temperature range from 3.62 to 3.72°K. The magnetization was found to be reversible and linear with the applied field $H_0 < H_{sh}$. Considerable superheating up to fields $H_{sh} = 2.25H_{cb}$ has been observed. (auth)

43952 SOLUBILITY CURVE AND MOLAR DENSITY OF DILUTE ^{3}He-^{4}He MIXTURES. Ifft, E. M.; Edwards, D. O.; Sarwinski, R. E.; Skertic, M. M. (Ohio State Univ., Columbus). Phys. Rev. Lett., 19: 831-3(Oct. 9, 1967).

The solubility curve has been measured at the saturated vapor pressure down to 0.025°K, and the limiting solubility at absolute zero has been determined to be $(6.37 \pm 0.05)\%$ ^{3}He. Measurements of the density show that at 0°K and small concentration the volume occupied by a ^{3}He atom in solution is 1.284 ± 0.005 times the volume occupied by ^{4}He. (auth)

43953 SUPERFLUID HELIUM FLOW THROUGH AN ORIFICE NEAR CRITICAL VELOCITY. Trela, W. J.; Fairbank, W. M. (Stanford Univ., Calif.). Phys. Rev. Lett., 19: 822-4(Oct. 9, 1967).

Measurements were made of the energy loss associated with the flow of superfluid helium near critical velocity through orifices. At certain temperatures a critical velocity is observed for each orifice below which no energy is lost from the flow, and above which a range of velocities is found where the energy loss agrees with the predictions of Feynman concerning the formation of quantized vortex rings whose size is that of the orifice. (auth)

43954 EFFECT OF FERMI-LEVEL MOTION ON NORMAL-STATE PROPERTIES OF β-TUNGSTEN SUPERCONDUCTORS. Cohen, Roger W.; Cody, G. D.; Halloran, John J. (RCA Labs., Princeton, N. J.). Phys. Rev. Lett., 19: 840-4(Oct. 9, 1967).

Previous investigations have shown that β-tungsten compounds are of interest because of the anomalous temperature dependences of a variety of properties in both normal and superconducting states. It is thought that many of these anomalies are due to extremely fine structure in the electronic density of states near the Fermi level. Labbe and Friedel obtained machine calculations of the elastic constant $C_{11}-C_{12}$ as a function of temperature and were able to account for the tetragonal transformation observed by Batterman and Barrett in V_3Si. Clogston and Jaccario found that a narrow density-of-states anomaly at the Fermi level could explain measurements of the paramagnetic susceptibility χ of vanadium β-tungsten compounds. A model is presented of the electronic density of states which yields, with the choice of two parameters for Nb_3Sn, excellent agreement with the observed temperature dependence of χ, elastic constants C_{11} and $C_{11}-C_{12}$, and electrical resistivity ρ. Also, the temperature dependences of χ for V_3Si and V_3Ga are predicted. (J.H.M.)

43955 SUPERCONDUCTIVITY AT THE CONTACT REGION OF TWO MEDIA. Chaplik, A. V. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.), 9: 551-2(Sept. 1967).

Translated from Fiz. Tverd. Tela, 9: 701-3(Mar. 1967).

An examination is made of the contact between two semiconducting films with different concentrations of electrons and different values of the effective coupling constant. It is shown that under certain conditions the critical temperature of such a "sandwich" is higher than the critical temperatures of its parts. (auth)

43956 SUPERCONDUCTIVITY AND LOCALIZED MAGNETIC STATES. Tripathi, R. S. (Indian Inst. of Tech., Kanpur). Phys. Lett., 25A: 381-2(Sept. 11, 1967).

It is shown that in the Hartree–Fock approximation, an alloy containing magnetic impurities and in the superconducting phase, does not favor the localization of the magnetic moment in comparison to that of the metallic phase. (auth)

43957 ON THE CONCEPT OF PINNING FORCE IN TYPE II SUPERCONDUCTORS. Yamafuji, K.; Irie, F. (Kyushu Univ., Fukuoka). Phys. Lett., 25A: 387-8(Sept. 11, 1967).

It is pointed out that the former derivations of the pinning force in nonideal type-II superconductors are wrong in principle. An expression of pinning force is derived in case of a linear fluxoid lattice, as an example. (auth)

43958 SUPERHEATING OF THE MEISSNER STATE. Fink, H. J.; Presson, A. G. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Lett., 25A: 378-9 (Sept. 11, 1967).

The superheating and the critical fields of the Meissner state were calculated for a slab of thickness 2L for κ values between 0.3 and 2.4 and size parameters L/λ between 2 and 20. For very large values of L/λ the superheating field appears to approach the thermodynamic critical field H_c for κ values of order unity and larger contrary to previous predictions. (auth)

43959 DENSITY OF A DILUTE ^3He–^4He SOLUTION UNDER PRESSURE. Boghosian, C.; Meyer, H. (Duke Univ., Durham, N. C.). Phys. Lett., 25A: 352-3(Sept. 11, 1967).

The relative volume increase α (as defined by Bardeen, Baym and Pines) of a 6% liquid solution of ^3He in ^4He has been measured at temperatures between 1.25°K and 2.2°K and as a function of pressure. The extrapolated value at 0°K is in good agreement with theoretical predictions. (auth)

43960 NEW METASTABLE SOLUTIONS OF THE GINZBURG–LANDAU EQUATIONS. Fink, H. J.; Kessinger, R. D. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. Phys. Lett., 25A: 357-8(Sept. 11, 1967).

New solutions of the one-dimensional Ginzburg–Landau equations were found between H_c and their critical fields H_n for all κ values. (auth)

43961 PROXIMITY EFFECTS IN A FINE COMPOSITE. Strauss, B. P.; Rose, R. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Lett., 25A: 362-3(Sept. 11, 1967).

A fine Nb–Cu composite displays three distinct Meissner effects, two of which are due to primary and secondary proximity effects in the copper caused by the geometry of the composite. (auth)

43962 NUCLEAR SPIN RELAXATION IN SUPERCONDUCTING MIXED-STATE VANADIUM. Fite II, Warner; Redfield, Alfred G. (Columbia Univ., New York). Phys. Rev., 162: 358-67(Oct. 10, 1967).

Nuclear spin relaxation was studied by polarizing nuclear spins in 10 kG, quickly lowering the field to the mixed state, and after variable time applying 6 kG and observing a rapid-passage signal. Samples were wires and foils of resistance ratio up to 90, and were fairly reversible. In the normal state at 5.4°K, the relaxation rate at zero field is about one-third that at high field in these samples, the change in rate occurring at fields greater than 30 G. This behavior is attributed to electric quadrupole interactions due to residual imperfections in the lattice. In the zero-field (Meissner) superconducting state, T_1 becomes long at low temperatures, consistent with a gap of order $3.5kT_c$; but just below T_c, T_1 appears to be greater than in the normal state, in contrast to its behavior in other superconductors such as aluminum. This may be due to trapped flux; the possibility of strain-enhanced electric quadrupole relaxation was also considered but estimated to be negligible. In the mixed state, just above H_{c1}, where about half the sample is farther than a coherence length from a vortex, nonexponential decays are observed. Below 1°K the long component of the decay is spin-diffusion-limited, apparently, and the spin-diffusion coefficient is inferred and compared with theory. At these low flux densities the decay can be made nearly exponential by applying a few-gauss 100-Hz field during the time the sample is in the mixed state, presumably moving the vortex structure in and out and making a spin relax at the space-average rate. The space-average relaxation rate changes nearly linearly with flux density, from its normal-state value at H_{c2} to its zero-field superconducting value, at most temperatures. The resolution was not sufficient to establish significant impurity-dependent effects. (auth)

43963 LOCAL-FIELD MAPPING IN MIXED-STATE SUPERCONDUCTING VANADIUM BY NUCLEAR MAGNETIC RESONANCE. Redfield, Alfred G. (Columbia Univ., New York). Phys. Rev., 162: 367-74(Oct. 10, 1967).

A 10-kG field was applied to polarize the spins; it was then quickly reduced below H_{c2}, and remained there for about 0.1 sec, during which time a transverse ac probe field of frequency ν_p was applied. Then the large dc field was reapplied and a rapid-passage resonance signal observed in order to measure the effect of the probe field, the decrease in this subsequent signal reflecting the NMR absorption. Except near H_{c2} the probe field only burns a small hole in the nuclear magnetization, and it was also necessary to move the vortex structure about by applying a 100-Hz field of a few gauss during the time that the sample was in the mixed state. Detailed studies are reported for a multiple foil sample of vanadium with main field perpendicular to the surface; aluminum foil was interleaved, and the flux density B was measured using the ^{27}Al NMR by exactly the same field-cycling resonance as applied to the vanadium. The magnetization was measured ballistically in the same magnet and field cycle. For flux density around $\frac{1}{2} H_{c2}$ the line shape almost uniquely implies a triangular vortex lattice. At high probe power, the effect of the probe field is still confined to the same definite frequency range as at low power, as would be the case for a completely ordered vortex lattice; this implies order over several vortex-lattice spacings. Accurate measurements are presented of the field at a vortex center and at the saddle point halfway between two vortices, and of the average flux density B, as a function of H, in a fairly clean sample at 1.4°K. These parameters determine an accurate field map. Near H_{c2} the field at a vortex center equals H, with a deviation of second (or greater) order in $H-H_{c2}$. The linewidth is greater, for a given magnetization, than would be expected from solutions of the Ginsburg–Landau equations. By extrapolation to zero B, it is concluded that the field at the center of a vortex is 1.2 ± 0.2 times H_{c1}. The data are consistent, at low B, with a superposition model of independent vortices. (auth)

43964 CALCULATION OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF SUPERIMPOSED FILMS IN THE DIFFUSION APPROXIMATION. Jacobs, A. E. (Univ. of Illinois, Urbana). Phys. Rev., 162: 375-82(Oct. 10, 1967).

The de Gennes–Guyon–Werthamer theory of the proximity effect in the diffusion approximation has been extended by the use of coupled integral equations for the order parameters in the two metals. The two theories are in excellent agreement for Pb–Al superimposed films, but there are significant differences for Pb–Cu films. Several experiments have indicated that copper may be a superconductor ($T_c \approx 0.010$°K); in view of various theoretical and experimental uncertainties, it is concluded that most of this evidence for superconductivity in copper must be considered doubtful. It is shown that different methods of cutting off divergent sums occurring in the theory can give significantly different results, introducing a further theoretical uncertainty. (auth)

43965 LOW-TEMPERATURE SPECIFIC HEATS OF ANNEALED HIGH-PURITY NIOBIUM IN MAGNETIC FIELDS. Ferreira da Silva, J.; Burgemeister, E. A.; Dokoupil, Z. (Kamer-

lingh Onnes Lab., Leiden). Phys. Lett., 25A: 354-6(Sept. 11, 1967).

Specific heats of a bundle of annealed niobium wires of high purity were measured in the superconducting, mixed, and normal states. At the lowest temperatures, the specific heat in the mixed state for $H > H_{c1}(0)$ contains a field dependent term linear in T. The observed temperature dependence of the Maki parameters κ_1 and κ_2 is much higher than expected from any present theory. (auth)

43966 NMR RESULTS ON THE VARIATION OF T_c IN V_3Au WITH ATOMIC ORDERING. Van Reuth, E. C.; Poulis, N. J. (Kamerlingh Onnes Lab., Leiden). Phys. Lett., 25A: 390-1 (Sept. 11, 1967).

The superconducting transition temperature, the Knight shift, and the nuclear magnetic resonance line width of vanadium were measured in V_3Au compounds as a function of ordering. (auth)

43967 DERIVATION OF THE PRINCIPLE OF COMPENSATION OF DANGEROUS DIAGRAMS. Kobe, Donald H. (Uppsala Univ.). J. Math. Phys. (N. Y.), 8: 1200-10(June 1967).

The principle of compensation of dangerous diagrams (PCDD) postulated by Bogolyubov to determine the coefficients in the canonical transformation to quasi particles in superconducting systems is derived from four different criteria (1) the expected number of quasi particles in the true ground state is a minimum, (2) the one-particle density matrix and the two-particle amplitude determined from the BCS ground state are equated to the true ones, (3) the expectation value of an arbitrary operator is simplified by diagonalizing its quadratic part, and (4) the starting point for the dressing of the quasi particle is chosen in the most convenient way. The condition obtained for the PCDD is then expressed in terms of quasi-particle Green's functions. The ladder diagrams are eliminated by examining an integral equation for the Green's function describing the creation of two quasi particles from the vacuum. Finally, the condition obtained here for the PCDD is compared with the condition obtained previously. (auth)

43968 ELECTROMAGNETIC BEHAVIOR OF SUPERCONDUCTORS WITH IMPURITY SCATTERING. Wong, M. K. F. (Woodstock Coll., Md.). J. Math. Phys. (N. Y.), 8: 1443-8 (July 1967).

A general equation for the electromagnetic current J of a superconductor responding to a frequency-dependent external electromagnetic field and under the influence of impurity scattering and temperature was derived in momentum space using the Green's function method. This general equation can be regarded in two ways. (a) It is the Fourier transform, from coordinate space to momentum space, of the equation of Mattis and Bardeen. (b) It summarizes, in one equation, the previous works of Abrikosov et al. on the electromagnetic behavior of superconductors. In addition to these general properties, this equation also shows, in particular, that for a superconducting alloy with a few percent of impurity concentration, the kernel for the current is the same as that of a Pippard pure superconductor, with $\frac{3}{16}vk$, where v is the Fermi velocity and k is the momentum exchange during collision replaced by τ_{tr}, the transport collision time, valid for all temperatures up to T_c, the transition temperature. Expressions of the current in closed form for both superconducting alloys and normal metal with impurity are also given for $vk \sim 1/\tau$. (auth)

43969 ABSORPTION OF ULTRASOUND IN THE INTERMEDIATE STATE OF SUPERCONDUCTORS. Andreev, A. F. (Inst. of Physical Problems, Moscow). Zh. Eksp. Teor. Fiz., 53: 680-8(Aug. 1967). (In Russian).

The ultrasound absorption coefficient in the intermediate state of a superconductor of the first kind at low temperatures is calculated. It is assumed that the electron mean free path l and the Larmor radius in the critical magnetic field R are much greater than the wave length and thickness of the normal layers. The absorption is proportional to the first power of the sound frequency if the wave length is much smaller than the layer thickness and proportional to the square of the frequency in the opposite extreme case. Absorption oscillations should be observed on variation of the external magnetic field, the oscillation period being dependent on the thickness of the normal layers. It is shown that sound absorption measurements permit one to determine the period of the structure of the intermediate state as a function of the magnetic field strength. (auth)

43970 SUPERCONDUCTING CHARACTERISTICS OF RATHER CLEAN THIN FILMS IN STRONG PARALLEL FIELDS. Thompson, R. S. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 759-66(Aug. 1967). (In Russian).

The Green's functions of a thin film superconductor are calculated to all orders in the order parameter in the presence of very strong magnetic fields parallel to the surface, when expansion in powers of the field strength is not appropriate. From these Green's functions the magnitude of the order parameter and the tunneling current are calculated near the critical field. (auth)

43971 WAVE PROCESSES IN A PLANE-PARALLEL CAPILLARY FILLED WITH He II. Adamenko, I. N.; Kaganov, M. I. Zh. Eksp. Teor. Fiz., 53: 615-25(Aug. 1967). (In Russian).

Wave processes occurring in a plane-parallel capillary filled with He II are considered. The velocities and damping coefficients of fourth sound and thermal wave in capillaries possessing different ratios between the viscous wave width and length are calculated. The relation between the amplitudes of first, second sounds and the viscous wave are derived for the case of fourth sound and a thermal wave. The theoretical results are compared with the experimental data. (auth)

43972 CURRENT-CARRYING PROPERTIES OF SUPERCONDUCTING LEAD-BISMUTH ALLOYS. Litomisky, M.; Sirovatka, J. Cryogenics, 7: 40-1(Feb. 1967).

Experimental investigation of the critical properties of superconducting lead-bismuth alloys indicates that the critical current density is almost constant for bismuth concentrations of more than 40%; due to the more favorable physical properties of alloys with lower bismuth concentrations, alloys containing 40 to 50% bismuth may be more suitable for some cryogenic applications than the more commonly used eutectic mixture. (UK)

43973 FEATURES CONCERNING THE LOWER CRITICAL FIELD OF AN INTRINSIC TYPE-II SUPERCONDUCTOR. French, R. A. Cryogenics, 7: 52-3(Feb. 1967).

Measurements of the magnetisation curves of pure niobium confirm the existence of a second-order phase transition of the λ type at the lower critical field H_{ci}. (UK)

43974 EFFECT OF STRESS ON THE SUPERCONDUCTIVE TRANSITION TEMPERATURE OF STRONTIUM TITANATE. Pfeiffer, E. R.; Schooley, J. F. (National Bureau of Standards, Washington, D. C.) Phys. Rev. Lett., 19: 783-5(Oct. 2, 1967).

The superconductive transition temperatures T_c of single-crystal specimens of reduced strontium titanate have been measured as functions of hydrostatic and uniaxial compressional stresses up to 1.5 kbar. The prominent features of the experimental results are a large, nonlinear, hydrostatic-pressure effect and an anisotropic uniaxial stress effect. The relative decrease of transition temperature with pressure $\Delta(\ln T_c)/\Delta p$ is about an order of magnitude larger than that seen in metallic superconductors. (auth)

43975 LOSSES BY VORTEX DISPLACEMENT IN A NON-IDEAL TYPE-II SUPERCONDUCTOR. Baixeras, J.; Fournet, G. (Faculte des Sciences de Paris, Fontenay-aux-Roses, France). J. Phys. Chem. Solids, 28: 1541-7(Aug. 1967). (In French).

It has been suggested that losses in type-II superconductors in the mixed state carrying an electric current are related to moving vortices. A statistical treatment is proposed, taking into account this motion in a nonideal substance, i.e., containing every kind of defect: structural defects, impurities, phase precipitation. Using this analysis, the distribution function of pinning forces in the sample can be determined. Comparison between the model corresponding to this theory and the experimental data indicated good agreement. (auth) (UK)

43976 CRYOSTATS OF A NEW TYPE FOR SUPERCONDUCTING COILS. Keilin, V. E. (Kurchatov Atomic Energy Inst., Moscow). Cryogenics, 7: 3-6(Feb. 1967).

The design of wide-necked cryostats which are to contain fairly large pieces of apparatus and yet have a reasonable evaporation rate has received attention in a programme for testing superconducting coils carried out in the U.S.S.R. Details are given of several improved versions with inner diameters of up to 300 mm. (auth) (UK)

43977 50-c/s LOSSES IN COILS MADE WITH SUPERCONDUCTING WIRE. Pech, T.; Fournet, G. (Laboratoire Central des Industries Electriques, Fontenay-aux-Roses, France). Cryogenics, 7: 26-32(Feb. 1967).

In spite of the increasing use being made of superconducting coils, experimental data on ac losses are still sparse. Using a calorimetric method, results were obtained for ac power losses in a number of coils wound with niobium-zirconium wire, and the dependence of losses on current and field was studied. (auth) (UK)

43978 COMPRESSIBILITIES FOR HELIUM AT TEMPERATURES FROM 70 TO 120°K AND PRESSURES TO 690 atm. Sullivan, J. A.; Sonntag, R. E. (Univ. of Michigan, Ann Arbor). Cryogenics, 7: 13-7(Feb. 1967).

Method, apparatus, and experimental results are presented from an investigation which is part of a major study of the low temperature compressibilities of pure gases. (auth) (UK)

43979 ELECTRON MIRROR OBSERVATION OF SUPERCONDUCTORS IN THE INTERMEDIATE STATE. Bostanjoglo, O.; Siegel, G. (Technical University of Berlin). Cryogenics, 7: 157-60(Feb. 1967).

A new instrument to investigate the magnetic domain pattern of superconductors (niobium, niobium stannide, vanadium, lead, and tantalum) in the intermediate state with higher resolution than achieved by other methods is the low temperature electron microscope. Structures with size down to 20 μ were observed. The patterns depend on the preceding treatment (mechanical working, annealing, etc.) of the samples. (auth) (UK)

43980 SUPERCONDUCTING MAGNET FOR AN 8-mm TRAVELLING-WAVE MASER. Hentley, E. L. (Mullard Research Labs., Redhill, Eng.). Cryogenics, 7: 33-5(Feb. 1967).

A design which eliminates the superconducting magnetic insulator shields required to obtain the field uniformity necessary for the operation of travelling-wave solid-state masers is described. This type of construction, previously used at fields up to 4 kOe, has been extended for use at a field of 10.2 kOe. (auth) (UK)

43981 COMPARATIVE REVIEW OF MATERIALS FOR CONSTRUCTION OF SUPERCONDUCTING SOLENOIDS. Prior, A. C. (Royal Radar Establishment, Malvern, Eng.). Cryogenics, 7: 131-4(Feb. 1967).

Some problems in the manufacture and use of the materials commonly abailable for high-field superconducting solenoids are discussed. Comparative data are presented in graphical form for the critical current density as a function of field, and also the overall values that can be achieved in small solenoids. Data on prices are also given. Some general remarks on the β-tungsten compounds are included. (auth) (UK)

43982 RISE-RATE DEPENDENCE OF THE CRITICAL CURRENT OF SUPERCONDUCTING SOLENOIDS. Meyerhoff, R. W. (Union Carbide Corp., Indianapolis). J. Appl. Phys., 38: 3913-17 (Sept. 1967).

The influence of charging current rise rate on the maximum operating current was determined for a 42-layer Nb–Zr solenoid 15.24 cm long with an ID of 3.05 cm and an OD of 5.74 cm which generated a magnetic field of 1.4 kG/A. A rise rate of 10.7 A/sec (15 kG/sec) was found to lower the maximum operating current of this solenoid by ~30%. In addition, the rise-rate dependence of the transition current was determined with various configurations of built-in electrical shorts. In all cases, the presence of a short greatly increased the rise rate dependence, and in several cases led to depression of the transition current by more than 50% for rise rates as small as 0.2 A/sec (0.28 kG/sec). These results indicate that the strong rise-rate dependence of the transition current observed in some superconducting solenoids arises from the presence of shorts, and is influenced more strongly by the rate of change of field than by the current rise rate. Several relations have been derived which accurately predict the rise-rate dependence of the critical current of a shortened superconducting solenoid. (auth)

43983 PEAK EFFECT IN SUPERCONDUCTING Nb–15 AT. PERCENT Zr–45 AT. PERCENT Ti ALLOYS. Doi, T.; Ishida, F.; Kawabe, U. (Hitachi Ltd., Tokyo). J. Appl. Phys., 38: 3811-12(Sept. 1967).

The $H-I_c$ characteristics of Nb–15 at.% Zr–45 at.% Ti alloys are experimentally discussed in relation to metallurgical structure, particularly precipitation. Peak effect may be due to the random distribution in barrier heights and the interaction between flux lines at the magnetic fields near H_{c2}. (auth)

43984 FLUX JUMPING IN SYNTHETIC HIGH-FIELD SUPERCONDUCTORS. Watson, J. H. P. (Corning Glass Works, N. Y.). J. Appl. Phys., 38: 3813-17(Sept. 1967).

The magnetic field, H_{fj}, of the first flux jump during the initial magnetization of synthetic high-field superconductors, composed of indium in porous glass, has been measured as a function of the temperature and the field-sweep rate dH/dt. The behavior is reasonably well described by $H_{fj} \propto \log(dH/dt)$. At low values of dH/dt, log H_{fj} is approximately proportional to 1/(dH/dt). It is shown that under rather special conditions the flux-jumping behavior depends upon the condition of the sample surface. (auth)

43985 ENERGY SPECTRUM OF ELEMENTARY EXCITATIONS IN LIQUID HELIUM. Lee, Deok Kyo (Washington Univ., St. Louis). Phys. Rev., 162: 134-42(Oct. 5, 1967).

The elementary excitations in liquid ^{4}He are studied using the Brillouin–Wigner perturbation theory. For the four-particle distribution function occurring in the third-order energy correction, a convolution approximation is introduced, which generates the corresponding convolution form for the three-particle distribution function in the sequential relation. The proposed convolution form proves useful in estimating matrix elements. To carry out the numerical evaluation of the elementary excitation spectrum, Massey's theoretical liquid-structure function is used with slight modifications. In the low-momentum region it is shown that the ratios of the second- and third-order energy corrections to the Feynman excitation spectrum are proportional to the square of the wave vector; the result for the excitation energy with the leading correction is $\epsilon(k) = (1-0.334\ k^2\ \text{Å}^2)\hbar^2k^2/2mS(k)$, $k \ll \rho^{1/3}$. (auth)

43986 QUANTUM THEORY OF SUPERFLUID VORTICES. I. LIQUID HELIUM II. Fetter, Alexander L. (Stanford Univ., Calif.). Contract AF49(638)-1389. Phys. Rev., 162: 143-53 (Oct. 5, 1967).

A Hamiltonian formulation is constructed for the classical dynamical equations of slightly deformed rectilinear vortices. The system is then quantized by interpreting the conjugate variables as quantum-mechanical operators that obey canonical commutation relations. A linear canonical transformation diagonalizes the Hamiltonian in terms of operators that create and destroy single quanta of vortex vibrations. The theory is applied to two distinct configurations in He II: a single vortex and a rotating vortex lattice. The specific heat associated with the vortex waves varies approximately as $T^{1/2}$ at low temperatures. Quantum-mechanical and thermal fluctuations produce a finite mean-square displacement of the vortex core, which is studied both at T = 0 and at T > 0. (auth)

43987 LAMBDA CURVE OF LIQUID ^{4}He. Kierstead, Henry A. (Argonne National Lab., Ill.). Phys. Rev., 162: 153-61(Oct. 5, 1967).

The pressure P_λ and the derivatives $(dP/dT)_\lambda$ and $(d\rho/dT)_\lambda$ of the lambda curve of ^{4}He were measured as a function of temperature from the upper lambda point to the lower lambda point, using an apparatus of very high resolution. Empirical equations for P_λ and ρ_λ are presented, which represent the data very well and agree generally with previous measurements. These equations define the position and slope of the lambda curve in the ρ, P, T space to a higher order of accuracy and detail than has been possible before. (auth)

43988 SYSTEM OF BOSONS WITH ATTRACTIVE INTERACTIONS. Singh, K. K.; Kumar, Satish (Univ. of Delhi). Phys. Rev., 162: 173-85(Oct. 5, 1967).

The problem of a system of bosons at zero temperature, interacting via a strong short-ranged replusive interaction and a weak long-ranged attraction, is treated by the methods of quantum-field theory. It is shown that if the parameters of the attractive part of the interaction are suitably restricted, an approximation to the self-energy parts of the Green's functions, similar to that used by Belyaev for the case of purely repulsive interactions, leads to an excitation spectrum, which in the limit of small momenta represents phonons. The approximation also yields an N-body bound state corresponding to zero pressure. Apart from minor differences, these results are in agreement with an earlier calculation of Huang. (auth)

43989 TEMPERATURE PULSES IN DILUTE LIQUID ^{3}He–^{4}He MIXTURES NEAR 0°K. Sandiford, D. J.; Fairbank, Henry A. (Yale Univ., New Haven). Phys. Rev., 162: 192-8 (Oct. 5, 1967).

The speed of second sound in dilute liquid ^{3}He–^{4}He mixtures in concentrations up to 0.35% ^{3}He has been measured from 0.2 to 1°K at different pressures up to 20 atm. A pulsed time-of-flight technique was used. The second-sound values have been analyzed on Pomeranchuk's model, and the effective mass of the ^{3}He excitations has been obtained at different pressures, as well as different values of the roton parameters Δ and μ. The ratios of the effective mass of ^{3}He to the mass of a ^{3}He atom were found to be 2.55 at 46 cm Hg, 2.67 at 5.4 atm, 2.84 at 11.0 atm, and 3.03 at 19.8 atm. At the lowest temperature and especially at high pressures, the observations were complicated by poor coupling between phonons and ^{3}He excitations in the liquid, giving rise to two received pulses. From these measurements an estimate was made of the quantity λ^* that is thought to be closely related to the mean free path of phonons scattered by ^{3}He atoms. It was found that $\lambda^* \propto T^{-4}$. (auth)

43990 NORMAL-MODE ANALYSIS OF A SUPERFLUID MODEL. Knollman, G. C. (Lockheed Palo Alto Research Lab., Calif.). Can. J. Phys., 45: 3163-78(Sept. 1967).

An investigation is performed using normal-mode analysis on a quantum mechanical cell model whose general features are representative of ^{4}He at low temperatures. Both random-phase and self-consistent field approximations are invoked. A Bogolyubov-

type excitation energy spectrum is derived for the interacting Bose system, and the amplitudes of the system quasiparticles are obtained; these quantities are expressed in terms of zero-momentum occupation number. A relation giving the temperature-dependent fractional occupation of the single-particle zero-momentum level is established, and special attention is devoted to the temperature extreme near absolute zero. An estimate is made of the zero-temperature sound speed corresponding to the special case of phonon excitation given by the model in low momentum. It is shown that at a critical temperature for which the zero-momentum occupation is depleted, the quasiparticles indeed become normal Bose particles. In the first approximation, this critical temperature is akin in form to that obtained in treatments of ideal boson systems. (auth)

43991 ANHARMONIC CONTRIBUTIONS TO THE BULK MODULUS AND CHARACTERISTIC TEMPERATURES OF NEON AND ARGON AT T = 0°K. Brown, J. S.; Horton, G. K. Rutgers–The Univ., New Brunswick, N. J.). Can. J. Phys., 45: 2995-7 (Sept. 1967).

Anharmonic contributions to the bulk moduli of Ne and Ar are calculated for Lennard-Jones (m-6) potentials and compared with the experimental results at T = 0°K. Direct anharmonic contributions to the bulk moduli and the anharmonic contributions via the use of Brown's (1966) anharmonic potential parameters are considered. Excellent agreement is found with the experimental results of Peterson, Batchelder, and Simmons (1966) and Batchelder, Losee, and Simmons (1967). The effect of the anharmonic parameters on the Debye characteristic temperature obtained from C_v was also studied. Improved agreement with the experimental results is found. (auth)

43992 CRITICAL DATA OF NIOBIUM NITRIDE IN TRANSVERSE MAGNETIC FIELDS. Hechler, K. (Univ., Giessen, Ger.); Saur, E.; Wizgall, H. Z. Phys., 205: 400-8(1967).

Critical fields and critical currents of a great number of niobium nitride samples with and without different amounts of zirconium have been measured. The samples for these measurements have been prepared by diffusion of nitrogen into heated niobium and niobium–zirconium wires under various conditions. For the zero upper critical field of NbN the extrapolated value (153 ± 3) kOe has been found. The quenching curves of most of the samples show very pronounced peak effects in the high field region with a steep slope close to the upper critical field, which decreases with increasing amount of zirconium. (auth)

43993 PREPARATION AND SUPERCONDUCTING PROPERTIES OF PURE AS WELL AS ZIRCONIUM- AND TITANIUM-CONTAINING NIOBIUM NITRIDE. Hechler, K.; Saur, E. (Univ., Giessen, Ger.). Z. Phys., 205: 392-9(1967). (In German).

The preparation of pure, zirconium-containing, and titanium-containing niobium nitride samples by diffusion of nitrogen under pressure in niobium wires with and without zirconium or titanium additions is described. Under favorable preparation conditions the transition to superconducting is very steep (transition region below 0.1°K). For pure niobium nitride the highest transition temperature of 16.7°K was observed. The transition temperature was raised by low titanium additions, but lowered by zirconium additions. (tr-auth)

43994 EDDY CURRENT METHOD FOR LOW TEMPERATURE RESISTIVITY MEASUREMENTS. Daybell, Melvin D. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. Rev. Sci. Instrum., 38: 1412-15(Oct. 1967). (LA-DC-8638).

A modified mutual inductance bridge incorporating a commercial phase-lock amplifier has been used to measure low temperature bulk resistivities in the range from 1 to 10,000 nΩ cm. No electrical contact is required with the spherical metal samples, so that possible heat leakage along electrical leads is eliminated, and measurements can be made below 40 mdeg Kelvin using a dilution refrigerator. The bridge circuit, capable of determining resistivity changes with a precision of better than 0.3%, is described. (auth)

43995 MECHANISM FOR CONTROL OF SUPERCONDUCTING POINT CONTACT CHARACTERISTICS. Contaldo, A. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Sci. Instrum., 38: 1543-4(Oct. 1967).

An apparatus for delicate control of superconducting-metal-point contact pressure is described. The principal feature is a differential threaded mechanism which transforms the rotation of a control rod into a fine linear motion at the points. (W.H.K.)

43996 NEW METHOD FOR POINT TUNNELING INTO SUPERCONDUCTORS. von Molnar, S.; Thompson, W. A.; Edelstein, A. S. (IBM Watson Research Center, Yorktown Heights, N. Y.). Appl. Phys. Lett., 11: 163-4(Sept. 1, 1967).

A novel point tunneling technique for superconductors is reported. This technique employs the intrinsic barrier layer formed between a degenerate GaAs point and the superconducting metal surface. Excellent agreement between theoretical and experimental conductance curves is obtained for polycrystalline lead. (auth)

43997 OBTAINING ULTRA-LOW TEMPERATURES WITH SUPERCONDUCTING MAGNETS AND ADIABATIC DEMAGNETIZATION. Anderson, A. C. Cryog. Eng. News, 2: 74-6(Aug. 1967).

Obtaining ultralow temperatures (0.001°K) by the use of superconducting magnets and adiabatic demagnetization is discussed. A demagnetization refrigerator is briefly described. (W.D.M.)

43998 ENHANCEMENT OF THE MEISSNER EFFECT IN TYPE-II SUPERCONDUCTORS BY A HEAT PULSE. LeBlanc, M. A. R.; Griffiths, D. J.; Mattes, H. G. (Univ. of Southern California, Los Angeles). Appl. Phys. Lett., 11: 143-6(Sept. 1, 1967).

A transient increase of the temperature of the surface of a type-II superconductor cooled in a static magnetic field causes flux expulsion and enhances the final diamagnetic moment. It is argued that a net paramagnetic current is induced at the surface of the specimen during the initial cooling in a static magnetic field. Quenching of this surface current by a heat pulse permits flux expulsion. (auth)

43999 STUDIES OF SUPERCONDUCTING Nb-25 PERCENT Zr WIRES CARRYING ALTERNATING CURRENT IN AN AXIALLY APPLIED MAGNETIC FIELD. Taylor, Henry F. (Rice Univ., Houston, Tex.). Appl. Phys. Lett., 11: 169-71(Sept. 1, 1967).

The application of an axially directed magnetic field has been observed to reduce ac losses considerably in superconducting Nb–25% Zr wires. It has been found that magnetization curves measured with constant-amplitude ac flowing in a wire sample are paramagnetic-shifted with respect to curves measured with no externally supplied current. The presence of an axially applied field has been observed to increase the ac critical current with a maximum at about 2½ kG applied field. (auth)

44000 ULTRASONIC ATTENUATION IN SUPERCONDUCTING TIN AT VARIOUS AMPLITUDES OF THE ULTRASONIC PULSE. Chaudhuri, K. D.; Jain, M. C. (Univ. of Delhi). Appl. Phys. Lett., 11: 157-8(Sept. 1, 1967).

The effect of amplitude of the ultrasonic pulse on the attenuation of pure and impure single crystals of superconducting tin has been studied for the strained as well as annealed specimens. It has been found that small amplitude favors oscillations and the temperature-dependent attenuation is strongly dependent on the strain content of the specimen and slightly on amplitude. (auth)

44001 NUCLEAR MAGNETIC RESONANCE STUDIES IN THE NORMAL AND SUPERCONDUCTING STATES OF SOME V_3X COMPOUNDS. Silbernagel, Bernard George. San Diego, Calif., Univ. of California, 1966. 249p.

Thesis.

The properties of a series of intermetallic compounds with the β-W crystal structure and the chemical composition V_3X (where X = Si, Ga, Ge, Pt, Ir) have been investigated in the normal and superconducting state using the techniques of Nuclear Magnetic Resonance (NMR). Pulse NMR measurements have been made on the powder samples to determine spin-spin relaxation time (T_2) and the spin-lattice relaxation time (T_1) of the ^{51}V nuclei as a function of resonance parameters and temperature (T) from T = 500°K to T = 1.35°K. Steady-state NMR measurements have been made on single crystals of V_3Si to determine the line positions, the line widths, (ΔH), the strength of the nuclear quadrupole (e^2qQ) and the Knight shift of the ^{51}V resonance as a function of the resonance parameters, the sample orientation and T from T = 77°K to T = 16.9°K. For temperatures above the superconducting transition temperature (T_c), the value of T_2 is approximately equal for all V_3X compounds. A study of the linewidth of the single crystal resonance indicates that the primary spin–spin interaction is due to dipolar coupling of the nuclear spins, and the value of T_2 obtained is consistent with dipolar coupling in the case of a strongly quadrupolar broadened line. The parameter $1/T_1T$ is temperature dependent, in contrast to the temperature independent behavior observed in most metals, which indicates that the configuration of the conduction electrons in these compounds is peculiar. The compound V_3Si undergoes a martensitic transformation from a cubic to a tetragonal crystal structure at a temperature (T_m) just above T_c ($T_m \cong 20.5$°K). The value of $1/T_1T$ in V_3Si, V_3Ge and V_3Pt increases just above T_c, and a splitting of the resonance lines below T_m in V_3Si is observed by steady state NMR. This splitting increases as T is lowered below T_m and is found to be singular under the application of uniaxial stress along the [100] direction of the crystal. These measurements indicate that there is a close correlation between the crystal structure and the elec-

tronic properties of these compounds. The value of T_2 increases below T_c. The spin–spin interaction is decoupled by microscopic magnetic field inhomogeneities caused by penetration of the magnetic field in these type II superconductors. The value of T_1 below T_c behaves as expected on the basis of the Bardeen–Cooper–Schreiffer (BCS) theory of superconductivity and the gap in the conduction electron density of states caused by the superconductivity is found to be 3.5^{+1}_{-1} kT_c. For $T \ll T_c$, T_1 is shorter than expected on the basis of the BCS theory and this is attributed to relaxation of the nuclear spin system by nuclei situated at sites where the magnetic field penetrates. Rotation of powder samples of V_3Si saturates the nuclear magnetization. The details of this saturation process are not yet understood, but it may be due to fluctuation of the magnetic field or local heating during the rotation. (Dissertation Abstr.)

44002 PROPAGATION OF ZERO SOUND IN LIQUID ^{3}He. Abel, William Russell. Urbana, Ill., Univ. of Illinois, 1966. 67p. Thesis.

The propagation of sound in liquid ^{3}He was observed at a pressure of 0.32 atm and at frequencies of 15.4 and 45.5 MHz down to a temperature T^* of 2m°K (1m°K = 10^{-3}°K) on the temperature scale valid for the Curie-law magnetic susceptibility of powdered cerium magnesium nitrate in the form of a right circular cylinder with diameter equal to height. The results of the measurements have been published by the author, A. C. Anderson, and J. C. Wheatley. As the temperature was increased, the sound attenuation increased, went through a maximum, and then decreased. At low temperatures, the attenuation was proportional to T^{*2} but independent of frequency, and at higher temperatures it was proportional to ω^2/T^{*2}, where ω is the angular frequency of the sound. The temperature at which maximum attenuation occurred was 11.3m°K for the frequency of 15.4 MHz and was 19.3m°K for 45.5 MHz. The velocity of the sound was found to be relatively temperature independent at high and low temperatures but near the attenuation maximum the velocity changed by 3.5 ± 0.3%. The results of the measurements are predicted by the Landau theory of a Fermi liquid, the velocity change and the temperature dependence of the attenuation coefficient at low temperatures being explained by the propagation of a new mode of sound, called zero sound. The velocity change is in quantitative agreement with the theory. The attenuation of zero sound is about 35% larger than that predicted by theory, but could be explained by a shorter collision time between quasiparticles in the zero sound regime. The frequency and temperature dependence of the attenuation coefficient at higher temperatures are those predicted for ordinary hydrodynamic sound. (Disser. Abstr.)

44003 ADVANCES IN CRYOGENIC ENGINEERING. VOLUME 12. Proceedings of the 1966 Cryogenic Engineering Conference, Boulder, Colorado, June 13–15, 1966. Timmerhaus, K. D. (ed.). A Cryogenic Engineering Conference Publication. New York, Plenum Press, 1967. 801p. $25.00. (CONF-660605-(Vol.12)).

Separate abstracts were prepared for 13 of the included papers. Abstracts previously appeared in NSA for 6 of the remaining papers: 20:24183, 32850, 33560, 35807, 41539, and 21:719. (M.O.W.)

For abstracts of individual papers see: 43610, 43646, 44004–44014.

44004 STUDY OF STRATIFICATION SIMILITUDE LAWS IN LIQUID HYDROGEN. Bourgarel, M. H. (Centre d'Etudes Cryogeniques, Sassenage, France); Segel, M. P.; Huffenus, J. P. pp 103–11 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

The stratified layers similitude concept presented here for two geometrically similar tanks containing the same fluid does not require a boundary layer similitude. Experimental work has shown that stratification tests on small scale tanks when used with the previously established simple similitude laws allow one to extrapolate this data to full-size tanks. (auth)

44005 DESIGN AND DEVELOPMENT OF A TEST FACILITY FOR THE DISPOSAL OF HYDROGEN AT HIGH FLOW RATES. Thompson, W. R.; Boncore, C. S. (Aerojet-General Corp., Sacramento, Calif.). pp 207–17 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

The burn-pond concept has been demonstrated, for runs up to 100 sec, as an effective means of disposing of hydrogen at temperatures ranging from ambient to near the critical. (M.O.W.)

44006 THERMAL INSULATION FOR LIQUID HYDROGEN SPACE TANKAGE. Tariel, H. M.; Boissin, J. C.; Segel, M. P. (Centre d'Etudes Cryogeniques, Sassenage, France). pp 274–85 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Research was performed on Klegecell G-300, a rigid plastic foam comprised of polyvinyl chloride (PVC) chains cross-linked by an isocyanate bridge. These isocyanates are bonded on the PVC chains by a vinylidenic and maleic anhydride copolymer. This tridimensional structure tends to increase the mechanical properties and dimensional stability of the material at moderately high temperatures. (M.O.W.)

44007 MEASURING THE THERMAL CONDUCTIVITY OF IRRADIATED FOAM-TYPE INSULATION MATERIALS. Smith, E. T.; Miller, R. E. (General Dynamics/Fort Worth, Tex.). pp 315–21 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Tests were conducted to measure the effects of nuclear reactor radiation on the thermal conductivity of four foam type insulations (CPR-200-2, H-1502, EFS-175, and CPR-1021-2) at room, liquid-nitrogen, and liquid-hydrogen temperatures. (M.O.W.)

44008 A 4°K JOULE–THOMSON LABORATORY REFRIGERATOR. Currie, R. B. (Air Products and Chemicals, Inc., Allentown, Pa.). pp 557–63 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

A new source of 4°K cooling was designed to supplement the research dewars and closed-cycle refrigerators presently on the market. The performance and uses are described. (M.O.W.)

44009 PERFORMANCE OF A 4°K REFRIGERATOR. Stuart, R. W.; Hogan, W. H.; Rogers, A. D. (Arthur D. Little, Inc., Cambridge, Mass.). pp 564–75 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

A simplified, ideal gas analysis is given of a multi-staged refrigerator which takes into account the most important losses to show how an inefficient cycle can demonstrate reasonably good performance. Some of the latest developments of helium refrigerators, based on the Gifford–McMahon cycle, are discussed. (M.O.W.)

44010 SIZE AND POWER REQUIREMENTS OF 4.2°K REFRIGERATORS. Strobridge, T. R.; Chelton, D. B. (NBS Inst. for Materials Research, Boulder, Colo.). pp 576–84 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Data are given on the physical characteristics, thermodynamic cycles, thermal efficiency, refrigerator weight, and refrigerator volume. (M.O.W.)

44011 LIGHT-WEIGHT LIQUID HELIUM DEWAR. Simpkins, H. E.; Reed, R. L. (Beech Aircraft Corp., Boulder, Colo.). pp 640–5 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

The general design and performance are briefly described. (M.O.W.)

44012 COMMERCIAL HANDLING OF LIQUID HELIUM DEWARS. Van Meerbeke, R. C. (Air Reduction Co., Inc., Jersey City, N. J.). pp 646–56 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Safe and economical shipping methods for transporting liquid helium are discussed. (M.O.W.)

44013 SUPERCONDUCTING GYROSCOPE FOR GIMBALLED PLATFORM APPLICATION. Schoch, K. F.; Darrel, B. (General Electric Co., Schenectady, N. Y.). pp 657–65 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

Major design features of the gyroscope are outlined. (M.O.W.)

44014 20^0K IN-PILE IRRADIATION FACILITY. Conte, R. R. (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). pp 673-7 of Advances in Cryogenic Engineering. Volume 12. Timmerhaus, K. D. (ed.). New York, Plenum Press, 1967.

From Cryogenic Engineering Conference, Boulder, Colo., June 13–15, 1966. See CONF-660605.

A general description is given of a low-temperature irradiation device installed in the TRITON reactor at the Fontenay-aux-Roses Nuclear Research Establishment. (M.O.W.)

Plasma and Thermonuclear Physics

Refer also to abstracts 43110, 43185, and 44515.

44015 (NP-17048) WILLS PLASMA PHYSICS DEPARTMENT THIRTEENTH SIX-MONTHLY PROGRESS REPORT, JANUARY 1ST–JUNE 30TH 1967. (Sydney Univ. (Australia). School of Physics). 9p. (PR-13). Dep. CFSTI.

A brief review is given of work carried out at Sydney University during this period. The operation of the SUPPER machines, J × B ionizing fronts, compressional wave studies, microwave reflection studies, microwave propagation, and lasers, are briefly outlined. (M.O.W.)

44016 (ORNL-4150) THERMONUCLEAR DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING APRIL 30, 1967. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 156p. Dep. CFSTI.

Separate abstracts were prepared for 8 of the 9 sections. (M.O.W.)

For abstracts of individual sections see: 43752, 43753, 43946, 44020, 44021, 44128, 44129, and 44141.

Confinement and Heating of Plasma

Refer also to abstracts 43753 and 44126.

44017 (CONF-660421-3) ANOMALOUS BEHAVIOR OF GAS DISCHARGES IMMERSED IN STATIC MAGNETIC FIELDS. Powers, E. J. (Texas Univ., Austin. Labs. for Electronics and Related Science Research). [nd]. Contract AT(40-1)-3516. 9p. Dep. CFSTI.

From 18th Annual Southwestern IEEE Conference and Show, Dallas.

A review is presented of some of the major characteristics of anomalous diffusion in dc and rf glow discharges. (M.O.W.)

44018 (CONF-670810-4) ENHANCED PLASMA TRANSPORT IN LOW-PRESSURE HIGH-FREQUENCY DISCHARGES. Powers, E. J.; Mumola, P. B. (Texas Univ., Austin). [1966]. Contract AT(40-1)-3516. 4p. Dep. CFSTI.

From 8th International Conference on Phenomena in Ionized Gases, Vienna, Austria.

The experiments were carried out in glass tubes utilizing H_2, D_2, He, N_2, and Ar, with operating pressures extending from a few microns to approximately 1.0 torr. The enhanced diffusion as a function of the parallel magnetic field is described. (M.O.W.)

44019 (N-67-21766) MINIMUM TEMPERATURE OF A MAGNETIZED PLASMA. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Dec. 30, 1966. 27p. CFSTI.

A temperature limit exists below which a fully ionized plasma cannot be sustained within the main part of the confinement volume. The heating power which is needed to sustain the plasma just above this limit will become a measure of the plasma confinement and can be used to investigate the efficiency of magnetic bottles at low plasma temperatures. The theory is applied to a rotating plasma where it is found that the temperature limit corresponds to a limit of the rotation velocity below which the plasma cannot be kept in a fully ionized state. Further application is given to a nonrotating plasma which is sustained by ohmic heating from an imposed azimuthal current. The current has a lower limit which is a measure of the longitudinal plasma losses at a fixed plasma density and magnetic field strength. (auth) (STAR)

44020 (ORNL-4150, pp 1-35) PLASMA THEORY AND COMPUTATION. (Oak Ridge National Lab., Tenn.).

A study was made of toroidal magnetic field configurations which might be suitable for microwave generation of a target plasma. Progress in the analysis of toroidal field configurations is described. Several illustrative problems in the analysis of nonlinear plasma phenomena have been included. The coupling of plasma oscillations, ion sound waves, and electromagnetic waves has been computed using third-order perturbation methods, and expressions are given, for example, for the power radiated from a plasma in which the fluctuation level has some arbitrary power spectrum. Also displayed is a pair of coupled differential equations (for the particle distribution function and the fluctuation energy spectrum) which include in a compact and nondivergent form the Balescu–Lenard equation for a stable plasma and the quasi-linear equations of Pines and Schrieffer for an unstable plasma. Detailed studies of high-frequency, flutelike instabilities of importance to the target plasma program have provided a useful estimate of the amount of energy spread which must be achieved in the injection of fast particles if gross instability is to be avoided. The current status of this program is reviewed briefly. The new developments in the dielectric properties of plasma media and their exploitation in the analysis of inhomogeneous plasma configurations are described. A method is presented for evaluating the dielectric tensor for a cylindrical plasma (whose electrostatic eigenmodes are then cylindrical waves) in an axially symmetric magnetic field with gentle curvature. A generalization is presented of the usual "quasistatic" analysis which treats plasma inhomogeneities through an idealized boundary value problem. The rate at which a fast "test" particle loses energy to a plasma through excitation of collective plasma oscillations has been investigated for a variety of increasingly realistic dielectric descriptions of the plasma medium, and recent results of this work are described. A primitive stochastic model of electron-cyclotron resonant heating is outlined which treats the particle–microwave-field interactions as collision processes. In this model it is possible to estimate heating rates and velocity-space scattering rates and thus to gain some insight into the fundamental scaling relations which characterize this plasma production/heating technique. The effect of a $\beta \neq 1$ plasma on the ignition of a D-T plasma is derived, and graphical results are presented. The minimum allowable $\beta_{vac} = 16\pi n_+ kT_+ / B^2_{vac}$ is about 0.17 at T = 15 keV. (auth)

44021 (ORNL-4150, pp 56-70) ELECTRON-CYCLOTRON HEATING. (Oak Ridge National Lab., Tenn.).

A 100-mA-equivalent, 20-keV neutral beam has been injected into the electron-cyclotron plasma (ECP) in the INTEREM facility. Since the amount of microwave power available for producing the ECP was only 20 kW cw, the resulting trapping efficiency is lower than that obtained with the full 40-kW INTEREM ECP last year. The density of hot ions is an order of magnitude greater with ECP trapping than with gas trapping as before and is slightly greater than 10^9 ions/cm^3 under favorable conditions. Density saturation effects such as might result from a hot-ion drift instability have not yet been seen. Experiments in ELMO employing 8-mm microwave power in a large cavity have shown our previous notions about the spatial distribution of relativistic electrons to be in error. The relativistic electrons reside in a thin layer near the cavity walls and are sufficiently dense to cause a 10 to 20% depression of the vacuum field. The electron-cyclotron plasma is created in a 2:1 mirror field with up to 2 kW of 8-mm microwave power. The belt of electrons from 3 to 4 cm in radial extent at an average radius of 9 cm creates the field depression. Flux coils placed around the microwave cavity typically indicate 40,000 Mx flux change when the microwave power is turned off. (auth)

44022 RADIO-FREQUENCY CONFINEMENT AND ACCELERATION OF PLASMAS. Motz, H. (Oxford Univ.); Watson, C. J. H. Advan. Electron. Electron Phys., 23: 153-302(1967).

The problem of single particle motions is considered, and special cases in which the equations of motion have been solved are summarized. Work in the following areas is also reviewed: theory of rf and combined rf and magnetostatic confinement of plasma, stability theory, theory of rf acceleration of plasma, experiments on rf confinement and acceleration of plasma, and possible applications of these ideas to fusion reactors. (A.G.W.)

44023 INVESTIGATION OF THE CAPUTRE OF PLASMA IN A CLOSED TRAP. Il'enko, B. P.; Lats'ko, E. M.; Zalkind, V. M. Zh. Tekh. Fiz., 37: 868-72(May 1967). (In Russian).

Plasmas were injected into a straight section of the racetrack both from inside and from outside the track and into a toroidal section from outside the track, and the plasma densities and distributions in a section of the machine 75 cm from the injection point were measured with probes. Electron densities up to 1.6×10^{12} cm^{-3} were observed in the entrapped plasmas. The dependence of the electron densities and distributions of the entrapped plasmas on the magnetic field strength and the injection point is discussed at some length. There was considerable difference between the behaviors of the plasmas injected by the two different conical plasma guns, but the difference between the two guns themselves is not described. It is concluded that of the three investigated modes of injection transverse to the magnetic field (at the center of a toroidal section from outside the track, at the center of a

linear section from outside the track, and at the center of a linear section from inside the track), injection in the toroidal section from outside the track leads to the greatest entrapment of plasma, and injection in the linear section from within the track, to the least. (ATD)

44024 STUDY OF THE PLASMA EXCITED BY A MICROWAVE FIELD NEAR THE CYCLOTRON RESONANCE FREQUENCY. II. CHARGED PARTICLE BALANCE IN THE PLASMA. Budnikov, V. N.; Vinogradov, N. I.; Golant, V. E. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 861-7(May 1967). (In Russian).

The investigation of plasmas excited by 9375-MHz microwaves in a 2.5-cm-diameter 80-cm-long glass tube containing hydrogen and located in a longitudinal magnetic field has been continued. Measurements of the steady charged particle concentrations in the plasmas were made. The charged particle concentration was found to oscillate with an amplitude of several tens per centum and a frequency of 50 to 100 kHz. The cause of these oscillations was not investigated; all the reported data were averaged over times long compared with the period of the oscillations. The pressure in the investigated plasmas ranged from 10^{-4} to 10^{-2} mm Hg, and the charged particle concentration, from 10^{9} to 10^{11} cm^{-3}. From the observed dependence of the steady state electron concentration on distance along the tube from the source of the exciting microwaves and an estimated value of the longitudinal diffusion constant, the lifetime of a charged particle was found to be nearly independent of pressure and equal to about 5×10^{-5} sec. This very short lifetime is ascribed to anomalous diffusion associated with the density oscillations. The observed lifetime agreed rather well with the value given by Bohm's formula ($16mfL^2/kT$, where m is the electron mass, f is the Larmor frequency, L in the mean free path, and T is the electron temperature). The dependence of the charged particle concentration on the microwave power and the pressure is discussed and it is shown that the experimental data are consistent with the assumption of an anomalous loss of electrons described by Bohm's formula. The experimental concentrations were several times lower than the values calculated from the balance equations without the assumption of anomalous diffusion. When the magnetic field had the mirror configuration the electron concentration at low pressures was about twice its value in a uniform field. The electron concentration was considerably smaller than the value calculated on the assumption of loss electrons only by the collision mechanism. It is concluded that in analyzing the charged particle balance in a plasma excited by microwaves one must take into account the possibility of anomalous loss of particles not associated with collisions. (ATD)

44025 STUDY OF THE PLASMA EXCITED BY A MICROWAVE FIELD NEAR THE CYCLOTRON RESONANCE FREQUENCY. I. ABSORPTION OF MICROWAVE POWER. Budnikov, V. N.; Vinogradov, N. I.; Golant, V. E.; Obukhov, A. A. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 851-60(May 1967). (In Russian).

The excitation of plasmas in a 2.5-cm-diameter 80-cm-long glass tube containing hydrogen at pressures from 10^{-4} to 10^{-1} mm Hg and located in a longitudinal magnetic field of up to 6 kOe, by 9375-MHz (3.2-cm) microwaves introduced through a 3-cm-diameter cylindrical waveguide which enveloped a portion of the discharge tube and was excited in the TE_{11} mode by a continuously operating 5-W oscillator was studied. The end of the discharge tube that projected into the waveguide was made conical for matching purposes. The longitudinal magnetic field was either uniform (within 1%) over 74 cm of the length of the discharge tube, or it was stronger near the ends, the mirror ratio being 1.4 or 1.8 and the distance between the magnetic mirrors, 68 cm. The microwave power absorbed in the plasma was determined by measuring the power flux in the waveguide toward and away from the plasma with the aid of unidirectional ferrite gates; the distribution of the microwave field along the discharge tube was measured with probes; and the electron density in the plasma was determined with the aid of a cylindrical cavity resonator enveloping the central portion of the discharge tube and excited in the TM_{010} mode in the 10 cm wavelength region. Electron densities up to 10^{11} cm^{-3} were observed. Plasma was produced in the discharge tube only when the magnetic field strength was such that the cyclotron frequency was within 1.5% of the frequency of the microwaves, but once excited, the plasma was maintained over a wider range of magnetic field strengths. The absorption of the right and left-hand circularly polarized components of the linearly polarized incident microwaves could be separately measured. The absorption and the electron density were both maximum when the magnetic field strength had its resonance value, but on the falling portion of each of the curves on the side of higher magnetic field strengths there was a small subsidiary peak. The origin of this subsidiary peak is not known, but it is suggested that it may be associated with the presence of a group of electrons with drift velocities exceeding their thermal velocities. When the magnetic field had the magnetic mirror configuration the absorption and electron density were greatest when the magnetic field had the resonance strength at the center of the discharge tube. The experimental results are discussed in terms of the theory of the propagation of plane electromagnetic waves in a uniform plasma with space dispersion, and qualitative agreement with the theory is shown. (ATD)

44026 STABILITY OF SIMPLE STATIONARY WAVES RELATED TO THE NONLINEAR DIFFUSION EQUATION. Eleonskii, V. M. Zh. Eksp. Teor. Fiz., 53: 592-7(Aug. 1967). (In Russian).

The stability of solutions of the simple wave type for a nonlinear diffusion equation is investigated by the quasi-classical approximation method. (auth)

44027 SHELL STRUCTURE OF A HOT-ELECTRON PLASMA. Ikegami, Hideo; Ikezi, Hiroyuki; Hosokawa, Minoru; Tanaka, Shigetoshi; Takayama, Kazuo (Nagoya Univ., Japan). Phys. Rev. Lett., 19: 778-83(Oct. 2, 1967).

Experimental evidence was found that, when microwave power is fed across the magnetic flux lines, the hot electrons form a closed-shell structure and that while the plasma is created mostly at the electron-cyclotron fundamental resonance, subsequent electron heating is performed at the electron–cyclotron harmonic resonance. (M.O.W.)

44028 ANNULAR CONFINEMENT OF HIGH TEMPERATURE PLASMAS. (to United States Atomic Energy Commission). British Patent 1,083,994. Sept. 20, 1967. Priority date Oct. 1, 1963, United States.

An annular system employing magnetic mirrors is described for stably confining a high-temperature plasma. Both the hydromagnetic interchange stability and single-particle confinement criteria are satisfied. (M.O.W.)

Diagnostics of Plasma

Refer also to abstract 43892.

44029 (AD-651512) INVESTIGATIONS OF OXYGEN PLASMAS. Final Report, November 1, 1963–January 31, 1967. Bhattacharya, A. K.; Wright, R.; Cahn, J. H. (Illinois Univ., Urbana. Gaseous Electronics Lab.). Feb. 1967. Contract AF19(628)-2391. 48p. (AFCRL-67-0181). CFSTI.

A study was made of detailed behavior of free electrons in various temperature states in oxygen plasmas. It was shown that one can account for the apparent discrepancy between the drift tube data and the microwave measurements by taking into account the detachment of electrons from the negative ions O_2^- by collisions with long-lived excited-state O_2 (singlet Delta-g) of the oxygen molecule. (TSS) (TAB)

44030 (MATT-547) SPECTROSCOPIC INVESTIGATION OF A TRIGGERED VACUUM SPARK AS A SOURCE OF LITHIUM IONS IN A MAGNETIC FIELD. Mehlman-Balloffet, G.; Wilson, E. (Princeton Univ., N. J. Plasma Physics Lab.). Oct. 1967. Contract AT(30-1)-1238. 22p. Dep. CFSTI.

A triggered vacuum spark has been tested in a magnetic field of several kG with a crossed field configuration. A lithium electrode was used and the lithium plasma thus produced has been observed in the vicinity of the arc. Some characteristics of the plasma have been estimated from spectroscopic data. Temperatures of a few eV, peak electron densities of the order of 10^{18} cm^{-3}, and ion drift velocities of about 10^{6} cm/sec represent typical plasma conditions. (auth)

44031 (N-67-23272) FIRST ORDER EFFECTS OF PRODUCTION ON THE CONTINUUM THEORY OF SPHERICAL ELECTROSTATIC PROBES. Cohen, Ira M.; Schweitzer, S. (Pennsylvania Univ., Philadelphia). Feb. 1967. 44p. (NASA-CR-83545; INDEC-47). CFSTI.

The analysis of spherical Langmuir probes, immersed in an infinite, homogeneous, slightly ionized, collision-dominated plasma, is given to first order in the smallness of a parameter characterizing the effects of ionization and recombination. The treatment is given as a double limit: mean free path $\ll$ sheath thickness $\ll$ probe radius and the weakness of production effects. The governing diffusion equations are solved to the lowest order in $\rho_p = r_p/\lambda_D$ and to first order in the smallness of the production parameter. Current–voltage characteristics are computed from integrals of the solutions and emphasis is placed on their interpretation with respect to measurements. The first-order effects of ionization and recombination are also discussed. (auth) (STAR)

44032 (N-67-25493) PULSED ELECTROMAGNETIC GAS ACCELERATION. Semiannual Progress Report, July 1–Decem-

ber 31, 1966. Jahn, Robert G.; von Jaskowsky, Woldemar F. (Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences). Jan. 1, 1967. 96p. (NASA-CR-83791; SAPR-9). CFSTI.

The distribution of current density throughout the exhaust plume of a pulsed plasma accelerator has been determined by magnetic probing, for discharge currents from 40,000 to 140,000 amperes, and pulse lengths from 20 to 80 microseconds. Back pressures from .05 micron to the ambient discharge chamber level of 100 microns are provided in a large plexiglas vacuum tank, which introduces a minimum of electrical and spatial interference with the plume development. Depending on the particular conditions, some fraction of the discharge current propagates out into the plume and, when pulse length is sufficient, attains a fixed spatial distribution which resembles that of the high current MPD arc. The new experiments to exploit this similarity, and to study the current stabilization process in more detail have been initiated. (auth) (STAR)

44033 (NASA-SP-153, pp 75-83) NUMERICAL STUDIES OF THE STEADY-STATE PLASMA SHEATH PROBLEM. Parker, Lee W. (Mount Auburn Research Associates, Inc., Cambridge, Mass.); Sullivan, Edward C. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center).

A study was made to clarify the numerical methods of infinite-boundary problems, so that systematic methods may be developed. Grid methods of computation are discussed. (M.O.W.)

44034 (NP-17039) FOCUSSED MICROWAVE SYSTEMS FOR PLASMA DIAGNOSTICS. II. INTERACTION WITH DIELECTRIC MEDIA. Richard, C.; Carswell, A. I. (RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.). Apr. 1966. Contract PD69-500000. 103p. (RCA-7-801-46).

The importance of phenomena such as diffraction, reflection, and refraction taking place in the interaction of a focussed microwave beam with a dielectric is investigated experimentally. Transmission measurements are conducted on various materials with dielectric coefficients between 1.03 and 2.6 for three different geometries (slab, wedge, cylinder). Geometrical optics models of the interactions are constructed and their predictions are compared with the experimental results. Refraction effects are found to be the most important source of errors. Phase ambiguities as well as additional complications introduced by off-focus position of the cylindrical dielectric are studied. All results are critically discussed in terms of their implications on the limitations of the focussed beam system for plasma diagnostics. (auth) (STAR)

44035 SUPERHIGH-FREQUENCY PHASOMETERS FOR PLASMA DIAGNOSTICS. Malykh, N. I.; Yampol'skii, E. S. (Inst. of Physics and Tech., State Atomic Energy Commission, USSR). Teplofiz. Vys. Temp., 5: 704-12(July-Aug. 1967). (In Russian).

Descriptions are given of the design and performance of phasometers used for plasma diagnostics in pulsed operation. Classifications encompassing all known phasometers are discussed and certain characteristics of phasometers are described. Extensive bibliographies are included. (R.V.J.)

44036 SPECTRAL STUDIES OF TEMPERATURE DISTRIBUTION IN THE ELECTRIC ARC CHANNEL OF ARGON PLASMA SOURCE WITH AXIAL FLOW. Pustogarov, A. V.; Yakovlev, E. A. Teplofiz. Vys. Temp., 5: 713-14(July-Aug. 1967). (In Russian).

Studies were made in an electric arc channel of a dc argon plasma. The source consisted of a tungsten ring cathode and copper anode with a 98×10^{-3} m-long channel. Measurements of the radial temperature distribution in arc channel was made with a spectrometer. The increase of current increased the temperature along the cross section of the channel, moreover, with the current increase from 20 to 100 A the temperature along the channel axis increased linearly from 13.5 to 16.4 $\times$ 10^3 K. (R.V.J.)

44037 STUDIES OF PLASMA JET OF HIGH-FREQUENCY ARGON TORCH. Gol'dfarb, V. M.; Donskoi, A. V.; Dresvin, S. V.; Klubnikin, V. S. (Leningrad Polytechnic Inst. Leningrad State Teacher's Inst.). Teplofiz. Vys. Temp., 5: 549-56(July-Aug. 1967). (In Russian).

The temperature distribution in a high-frequency argon torch was studied by an optical method and by means of a cylindrical, calorimetric probe. The optical and calorimetric temperatures differ at about 2000°K. The possible reasons for such discrepancy are discussed. (tr-auth)

44038 TEMPERATURE DETERMINATION IN STATIONARY INDUCTION DISCHARGE. Rovinskii, R. E.; Gruzdev, V. A.; Gutenmakher, T. M.; Sobolev, A. P. Teplofiz. Vys. Temp., 5: 557-61(July-Aug. 1967). (In Russian).

The radial temperature distribution and concentration of electrons, and the dependence of their maximum values on the magnitude of the discharge at a fixed pressure, was measured by the method of absolute intensity of spectral radiation of the discharge continuum initiated in a quartz flask filled with xenon or argon at 1 atm pressure. (R.V.J.)

44039 HOT LANGMUIR PROBE. Zherebtsov, V. A.; Lebedev, M. A. Teplofiz. Vys. Temp., 5: 568-73(July-Aug. 1967). (In Russian).

A method is suggested for determining the properties of hot probes. Data from hot and cold probes taken at identical conditions showed good agreement for cases in which the plasma perturbation by an emission current is negligible. (tr-auth)

44040 STARK EFFECT AT THE LINES OF SINGLY IONIZED NITROGEN. Berg, H. F.; Ervens, W.; Furch, B. (RWTH, Aachen). Z. Phys., 206: 309-18(1967). (In German).

A homogeneous and thermal plasma was produced by a modified T tube. In a shot to shot analysis the lines of several multiplets of singly ionized nitrogen were investigated as to their Stark effect. Densities were determined by comparing the measured halfwidths of some neutral helium lines with the well established theory of Stark broadening of these lines. The temperature followed from the relative intensities of the measured helium and nitrogen lines assuming partial thermal equilibrium. The results of this experiment deviate from previous measurements of Day et al., as well as from the theory of Stark broadening in isolated lines of the heavier elements by Griem. It is shown (1) that the broadening in N II is a rough factor of two larger than theoretically expected, (2) that line broadening in N II is proportional to the density, (3) that the Stark-broadened lines follow dispersion profiles to the distance of several half widths from the line center. (auth)

44041 STUDY OF PROPERTIES OF PLASMAS AT HYPER-FREQUENCIES. Gregory, B. C.; Mourier, G. Ann. Radioelec., 22: 121-56(Apr. 1967). (In French).

Two kinds of interaction between an electron beam and a plasma are examined. The plasmas used were formed by the positive column of a gas discharge (the gases used were helium, argon, mercury and cesium vapor). The electron density was measured by the following methods: (a) Langmuir probes; (b) perturbation of the resonance frequency of a cavity containing the plasma; and (c) dipolar resonance (L band). The electron temperature was measured using Langmuir probes, and in the case of helium, agreement is satisfactory with the temperature predicted by the simple theory of a positive column. The dipolar resonance was examined in detail both experimentally and theoretically. In particular, coupling to the plasma column in a waveguide around dipolar resonance was calculated, and an equivalent lumped circuit was obtained. Measurements made with an actual plasma in a waveguide have confirmed theory satisfactorily, provided collisions of electrons with the wall of the tube, for mercury and cesium discharges, are taken into account. A description is given of a method of modulation of an electron beam using the plasma at dipolar resonance as the oscillating circuit. Its interaction with an electron beam which passes through it was calculated. The field distribution in the plasma cavity is such that self-maintained oscillations can arise if losses in the plasma are not excessive. From the typical characteristics of plasmas at dipolar resonance these oscillations are theoretically possible. Even if losses are excessive, it is still possible to use these plasma resonators to modulate the beam; some simple calculations for a plasma klystron are made (L band). The surface waves on a plasma column in a glass tube with no continuous magnetic field applied are described. The first two azimuthal modes are examined. Experimental dispersion curves were obtained for a mercury discharge and were compared against the results given by a computer. An effective method of coupling to the dipolar mode (n = I) was found as a result of experiment. The attenuation of this mode was also measured and compared against a simple theory. In addition, this mode is inverse over a large part of its dispersion curve, and its coupling impedance to an electron beam along the axis of the system was calculated. Coupling impedances of 30 to 50 Ω were obtained; they lead to starting currents which are sufficiently low for a plasma carcinotron, even when losses are included. A short experimental study of an electron gun operated at relatively high pressure (10^{-3} torr) is described. This type of gun is difficult to use and attention is now being given to differentially pumped enclosures. (auth)

44042 DETERMINATION OF THE ELECTRON TEMPERATURE IN NONTHERMAL PLASMAS FROM THE INTENSITY RATIO OF SPECTRAL LINES OF A GIVEN ION. Suckewer, S.

(Inst. of Nuclear Research, Swierk, Poland). Phys. Lett., 25A: 405-6(Sept. 11, 1967).

The dependence of the electron temperature on the ratio of intensities of two spectral lines of a given ion for nonthermal plasmas is given. (auth)

44043 STARK BROADENING OF H_β, H_γ, AND H_δ: AN EXPERIMENTAL STUDY. Hill, R. A.; Gerardo, J. B. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 162: 45-55(Oct. 5, 1967).

Stark-broadened H_β, H_γ, and H_δ line profiles from a spatially uniform plasma column formed in a critically damped discharge tube were recorded with a rapid-scan spectrometer. A plasma temperature of ~2 eV was inferred from both H_β- and H_γ-to-continuum ratios. Values of the electron density were determined to an estimated accuracy of better than ±2% by means of two multiple-pass laser interferometers operating at infrared and visible wavelengths. Systematic errors in recording and analyzing the line profiles are estimated to be less than ±1.5%. For interferometric values of the electron density in the range (1.3 to 8.5) × 10^{16} cm^{-3}, the measured half-intensity widths of all the recorded H_β profiles agreed to within ±2% of the widths predicted by Stark-broadening theory. In this comparison, the ±2% represents the maximum scatter of the measured half-intensity widths where the theoretical widths were determined using the interferometric values of electron density taken as the standard. The total systematic error in this comparison is estimated to be less than ±3.5%. For H_γ the measured half-intensity widths ranged from 11 to 25% larger than that predicted by theory for electron densities in the range (1.3 to 7.1) × 10^{16} cm^{-3}. For H_δ the measured half-intensity widths are 7% narrower than that predicted by theory for electron densities in the range (1.3 to 2.8) × 10^{16} cm^{-3}. Because the H_β, H_γ, and H_δ profiles were recorded from the same plasma, systematic errors in measuring the electron density will affect the comparison of theory and experiment for each line in the same sense. Thus the relative systematic errors between the comparison of all three lines with the theory are estimated to less than ±1.5%. (auth)

44044 SPACE-CHARGE DISTRIBUTION IN A NEUTRAL PLASMA: VARIABLE MOBILITY CASE. Shimada, Katsunori (California Inst. of Tech., Pasadena). pp 303-7 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20-22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

A theoretical expression for the electron density in an electrically neutral plasma was obtained by using conditions for a self-consistent electric field and for continuity of the current density. The theoretical electron density is compared with the experimental density for its spatial dependence. Agreement is quite good except for the region of a plasma near the emitter where the assumptions made in the theory may no longer hold. (M.O.W.)

44045 TEMPERATURE MEASUREMENTS IN AN ARGON HIGH POWER ARC. Bauder, U. (Technische Hochschule, Munich). Z. Phys., 205: 303-12(1967). (In German).

Spectroscopic measurements of radial temperature distributions in the cylindric cascade arc of 5-mm diameter in argon at atmospheric pressure and 5 atm in the current range from 200 to 500 amperes are reported. The applied method is the determination of the absolute intensity of both appropriate atom and ion lines and of the continuum, where the influence of self-absorption was carefully examined by variation of the arc length in end-on observation. The measured axial temperatures were between 17,800 and 20,800°K at atmospheric pressure and between 13,700 and 14,100°K at 5 atm pressure. (auth)

44046 ORBIT ANALYZER PROBES FOR THE MEASUREMENT OF PLASMA TEMPERATURES. Loughran, D. J.; Schott, L.; Skarsgard, H. M. (Univ. of Saskatchewan, Can.). Can. J. Phys., 45: 3055-64(Sept. 1967).

An investigation is presented of two different probes, of the magnetic analyzer type, in which the magnetic field used for analysis of the particle orbits is also present in the plasma. Both probes employ a current collector whose distance from the aperture plane is adjustable. One probe (the charge-selective probe) collects charged particles of one sign, while the other (the charge-insensitive probe) collects particles of both signs. Assuming a Maxwell–Boltzmann distribution of electrons, the current collection characteristics are calculated for each probe. The use of these current characteristics for the measurements of the electron temperature is discussed. A procedure is also given for obtaining the mean electron velocity perpendicular to the magnetic field in the case of a non-Maxwellian velocity distribution. Finally, methods for measuring the ion temperature are presented for the special case of a small Debye length compared with the ion Larmor radius. (auth)

44047 CURRENT MEASUREMENTS IN HIGH-VOLTAGE RADIO FREQUENCY PLASMA DISCHARGES. Penfold, A. S.; Warder, R. C. Jr. (Litton Industries, Inc., Beverly Hills, Calif.). Rev. Sci. Instrum., 38: 1533-5(Oct. 1967).

Various methods of measuring currents in high-voltage radio-frequency circuits for studying plasma discharges generated by a solenoidal coil are reviewed, and the refinement of one method, which measures the voltage drop across an inductive element, is discussed. The voltage is determined using high-voltage probes with an oscilloscope readout. (W.H.K.)

44048 TEMPERATURE DISTRIBUTION IN AN ARGON PLASMA JET WITH A VARIABLE MASS FLOW. Cremers, C. J. (Univ. of Kentucky, Lexington); Pfender, E. New York, American Society of Mechanical Engineers, 1966, Preprint No. 66-WA/HT-50, 8p., $1.50. (CONF-661102-39). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

The temperature fields of both high- and low-mass-flux argon plasma jets were determined at an arc current of 400 A using a grating spectrometer. The temperature distributions in a jet cross section close to the nozzle exit were also measured for several intermediate mass flows and also at other currents. Differences in the observed profiles are explained in terms of the fluid and electromagnetic phenomena occurring in the plasma generator. Energy balance measurements were performed for various mass flows with a current of 400 A. (auth)

Kinetics of Plasma

Refer also to abstracts 44020, 44022, and 44298.

44049 (AD-651595) RESEARCH ON ELECTROMAGNETIC PLASMA ACCELERATION. VOLUME I. THE DEVELOPMENT OF A CW TRAVELING WAVE ACCELERATOR FOR THE PRODUCTION OF PINCHED PLASMA TOROIDS. Final Report, November 1963–December 1966. Penfold, Alan S.; Rosen, Richard M. (Litton Systems, Inc., Beverly Hills, Calif. Space Sciences Lab.). Jan. 31, 1967. Contract AF49(638)-1251. 114p. (Pub-6126(Vol.1); AFOSR-67-0979). CFSTI.

The development of a cw traveling-wave accelerator for the production and acceleration of high-speed pinched plasma toroids is described. The accelerator is a polyphase-driven electrical system. Mercury and argon-seeded mercury were used as test gases. A comprehensive technology was developed to compensate for the inductive back reaction of the plasma discharge on the coils producing the traveling-wave field. Severe and rapid thermal overloading of the walls of the plasma channel limited the run times to a few seconds. Several types of ceramic channels were tried but the problem remained. The short run times made proper utilization of the back-reaction compensating circuits an impossibility. However, evidence of plasma acceleration was obtained and microscopic discrete ring currents were observed in the plasma efflux. The axial Hall voltage was monitored and a maximum value of 1000 volts was recorded. (auth) (TAB)

44050 (AD-651601) RESEARCH ON ELECTROMAGNETIC PLASMA ACCELERATION. VOLUME II. AN INVESTIGATION OF THE VARIOUS PLASMA DISCHARGES SURROUNDING A SOLENOIDAL COIL EXCITED WITH CURRENT AT 4 MEGACYCLES. Final Report, January 1–December 31, 1966. Penfold, Alan S.; Warder, Richard C. Jr. (Litton Systems, Inc., Beverly Hills, Calif. Space Sciences Lab.). Jan. 31, 1967. Contract AF49-(638)-1251. 167p. (Pub-6126(Vol.2); AFOSR-67-0977). CFSTI.

Various discharges which occur surrounding a shielded solenoidal coil excited with current at 4 Mc are examined for the gases helium, nitrogen, neon, argon, krypton, and xenon in the pressure range 0.02 to 0.50 torr. Measurements are made of various electrical properties including the operating power and the resistance and inductance reflected into the driving circuit by the discharges. A limited amount of optical spectrographic data was obtained. Microwave measurements were also made for selected conditions. A total of twelve modes of operation of the discharges were observed including Bright and Dim modes. Discharges occur both inside the solenoidal coil and in the space surrounding it. The two types appear to be independent in the sense that they can occur alone or in concert. Various types of fine structure were observed including rings of highly luminous balls of plasma located around the outside of the coil. Power levels up to 4000 watts were used. The values of reflected resistance behave in a manner inconsistent with the observed changes of inductance when correlated through the medium of theory. The values of resistance exhibit only slight dependence on pressure and current except near threshold of the various modes. The maximum change in resistance with type of gas was a factor of two. (auth) (TAB)

44051 (AD-651803) AN INVESTIGATION AND ANALYSIS OF A PENNING PLASMA BEAM. Conrad, David Morris; Trivers, Aylmer Raynolds (Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering). Mar. 1967. 81p. (GE/EE-67-A-3). CFSTI.

Thesis.

Researchers have traditionally used an arc discharge and a confining magnetic field to create a collimated flowing plasma. The operational characteristics of a Penning ionization gage, modified to create a collimated flowing plasma without confining magnetic fields, are described. The electron temperatures and density of the flowing plasma are measured and tabulated. Evaluation of the results shows stable and nonstable operating areas of the generator as a function of the electric and magnetic fields and generator geometry. The charged particle density within the beam demonstrated resonance and antiresonance as a function of the electric and magnetic fields. (auth) (TAB)

44052 (CEA-R-3262) L'EFFET D'UN CHAMP DE CHARGE D'ESPACE RADIAL SUR LE MOUVEMENT DES PARTICULES DANS UN CHAMP MAGNETIQUE STATIQUE ET SOUS L'ACTION D'UNE ONDE POLARISEE CIRCULAIREMENT. (Effect of a Radial Space-Charge Field on the Movement of Particles in a Magneto-Static Field and Under the Influence of a Circularly Polarized Wave). Buffa, Antonio (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 65p. (In French). Dep.

The effect of a circularly polarized wave on a cylindrical plasma in a axial magnetostatic field and a radial space-charge field proportional to r is studied. Single particle motion is considered. The electrostatic field produces a shift in the cyclotron resonance frequency and, in case of high charge density, a radial movement of the off-resonance particles. In these conditions a radio-frequency particle resonance is also possible called "drift resonance." The drift resonance can be produced with whistler mode, and may be employed in ion acceleration. Afterwards parametrical resonances produced by space-charge field oscillations and collisional limits of theory are studied. Cases in which ion acceleration is possible are considered on the basis of a quantitative analysis of results. (auth)

44053 (CONF-670434-1) VARIATIONAL APPROACH TO THE CLASSIFICATION OF NONLINEAR MAGNETOHYDRODYNAMIC WAVES AND PLASMOIDS. Wells, Daniel R. (Miami Univ., Coral Gables, Fla. Dept. of Physics); Norwood, Joseph Jr. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center). [1966]. 8p. CFSTI.

From 10th AFOSR Contractors Meeting on Ion and Plasma Propulsion Research, San Diego, Calif.

Variational methods are used to determine the structure of dynamically stable plasmoids. The total energy of the plasmoids is varied subject to a set of constraint integrals on the flow. It is demonstrated that the resulting flow structure in an azimuthally symmetric geometry results in a plasmoid of the type observed experimentally when the angular momentum of the plasmoid is not conserved. This is the collinear vortex structure. New experimental results are presented which clearly demonstrate that the structures observed in mirror trapping experiments are of the type predicted by the variational calculation. The collinear plasmoid structures are shown to be members of a class of nonlinear transverse waves that trap and transport fluid mass. It is also demonstrated that a modification of these solutions that assumes conservation of angular momentum of the plasmoid describes another type of vortex structure which is centered on the magnetic field lines and moves at right angles to the field. This is the H-centered vortex structure. It corresponds to the vacuum field limit of the classical weak magnetoacoustic wave solutions. (auth)

44054 (NASA-SP-153) SYMPOSIUM ON COMPUTER SIMULATION OF PLASMA AND MANY-BODY PROBLEMS, HELD APRIL 19-21, 1967, AT THE COLLEGE OF WILLIAM AND MARY, WILLIAMSBURG, VIRGINIA. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center. College of William and Mary, Williamsburg, Va.). 440p. (CONF-670419). CFSTI.

This collection includes 24 full-length papers, 10 abstracts, 2 panel discussions, and a bibliography on computer experiments with charged particles, charged fluids, and plasmas. Separate abstracts were prepared only for the 24 full-length papers. (M.O.W.)

For abstracts of individual papers see: 43694-43699, 43854, 44033, 44055-44069, and 44210.

44055 (NASA-SP-153, pp 3-23) COMPUTER EXPERIMENTS ON THE MICROSCOPIC THEORY OF PLASMAS. Feix, Marc R. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center. College of William and Mary, Williamsburg, Va.); Massel, Gary A.; Weinstein, Richard H. (National Aeronautics and Space Administration, Langley Station, Va. Langley Research Center).

Three kinds of problems were treated: (1) the Fourier density function; (2) potential fluctuations; and (3) relaxation effects. For nonequilibrium plasmas, all three problems are intimately related to the prediction of a metaequilibrium in one dimension, i.e., the persistence of any stable distribution for times $T \ll (ND)^2/\omega_p$. This point was well established by the third problem, showing not only the existence of a metaequilibrium but giving good agreement for first-order scaling and measurements of the diffusion coefficient. (M.O.W.)

44056 (NASA-SP-153, pp 25-30) INVESTIGATIONS OF NONLINEAR BEHAVIOR IN ONE-DIMENSIONAL PLASMA MODEL. Dawson, J. M. (Princeton Univ., N. J. Plasma Physics Lab.).

The results of three experiments on the nonlinear behavior of one-dimensional plasmas are presented. The three experiments were the Landau damping of the large-amplitude plasma oscillation, mode coupling between two strongly excited plasma oscillations, and the turbulence generated by the passage of a weak beam through a plasma. (auth)

44057 (NASA-SP-153, pp 41-56) NONLAMINAR EFFECTS IN PLASMA SLAB OSCILLATIONS. Schneider, H. M.; Bers, A. (Massachusetts Inst. of Tech., Cambridge).

The dynamics of electrons which follow an initial displacement of the electron cloud in a cold plasma slab with tapered boundaries are presented. The behavior is quite different from the case where the slab has sharp boundaries. For a tapered slab, the time of first crossing depends on the amplitude of the initial displacement and the overtaking occurs for particles in the tapered region. If the initial displacement is small, overtaking takes place where ω_p' is a maximum and the time at which it occurs is inversely proportional to the initial displacement. (auth)

44058 (NASA-SP-153, pp 57-60) PRELIMINARY MEASUREMENTS OF NOISE IN A TWO-DIMENSIONAL ROD MODEL OF A PLASMA. Hockney, R. W. (Stanford Univ., Calif. Inst. for Plasma Research).

Computer models of the superparticle type grossly exaggerate the fluctuations (or noise) in a real plasma because, of necessity, each superparticle carries the charge of 10^6 or more electrons. A formula was derived for the mean square fluctuating field appropriate to a particular type of computer model. (M.O.W.)

44059 (NASA-SP-153, pp 85-90) NUMERICAL SOLUTION OF THE FOKKER-PLANCK EQUATIONS FOR A HYDROGEN PLASMA FORMED BY NEUTRAL INJECTION. Killeen, John; Futch, Archer H. (California Univ., Livermore. Lawrence Radiation Lab.).

The equations are solved by the algorithm described by Richtmyer. The scheme is numerically stable in practice, and there is no restriction on the time step. This is an essential part of the calculations because as the electron temperature increases, the transfer rate decreases and the time step, Δt, must be continually increased during the calculation in order to progress toward equilibrium in a sensible manner. A plasma potential is computed at each time step of the calculation by requiring charge neutrality. A critical velocity, $v_c(t)$, is determined such that electrons with $v < v_c$ are not lost and that those with $v > v_c$ can be lost by scattering into the loss cone. At each time step, the electron density is compared to the ion density and v_c is modified accordingly. The plasma potential is obtained from $e\phi = \frac{1}{2}(mv_c^2)$. Numerical results are presented for a case with a source of 15-keV protons and 10-eV electrons. In this case, the particle densities increase from 10^5 to 10^{10} and the electron temperature from 10 eV to 200 eV. (M.O.W.)

44060 (NASA-SP-153, pp 91-136) NONLINEAR STUDY OF VLASOV'S EQUATION FOR A SPECIAL CLASS OF DISTRIBUTION FUNCTIONS. Roberts, K. V.; Berk, H. L. (California Univ., La Jolla, San Diego).

Calculations on the "water bag model" of a two-stream instability have been made by following the motion of the phase space boundaries. Although the distribution function is locally randomized, a large scale nonlinear wave is observed. This wave is due to the condensation of holes in phase space which formally acted as negative mass particles in that like charges attract one another. The subsequent development of the system depends on the dynamical interaction of the holes with each other and the plasma background. This evolution should be studied statistically, and to begin with, computer calculations have been made for a two hole collision. Statistically, the most probable final state of the simple water bag model is a Fermi distribution and it is important

to determine to what extent the actual dynamics allows the system to relax to this state. (auth)

44061 (NASA-SP-153, pp 137-44) NONLINEAR SOLUTIONS OF THE VLASOV EQUATION BY VELOCITY SPACE EXPANSION IN LAGUERRE POLYNOMIALS. Lomax, R. J. (Michigan Univ., Ann Arbor. Electron Physics Lab.).

If convective instabilities in a plasma are of interest and a closed system is being considered it is not possible to impose spatially periodic boundary conditions. An attempt was made to solve the Vlasov equation without this restriction. (M.O.W.)

44062 (NASA-SP-153, pp 155-61) NUMERICAL SOLUTION OF THE VLASOV EQUATION IN A FOUR-DIMENSIONAL PHASE SPACE. Killeen, John (California Univ., Livermore. Lawrence Radiation Lab.).

In the Lawrence Radiation Laboratory's controlled-fusion experiment, Astron, relativistic electrons are injected into a cylindrical region containing an applied magnetic field. The object is to form an E layer—a cylindrical layer of electrons—so that the self-field exceeds the applied field. The resulting configuration is intended to be axially symmetric with no azimuthal component of the magnetic field. The mathematical model for the buildup of the electron layer and the self-field is the time-dependent Vlasov equation coupled with Maxwell's equations. Although transient radial and axial currents exist in this model, particularly in the early stages of formation and near the injection point, these are assumed to be small compared to the azimuthal current. Field components B_r and B_z can be derived from stream function $\psi(r,z,t)$. The canonical angular momentum, p_θ, is a constant of the motion, and it is assumed that all electrons are injected with the same value of p_θ. Hence, one can consider an electron-distribution function, f, defined in a four-dimensional phase space (r, z, p_r, p_z). The system is assumed to be electrically neutral at every point. The ion distribution is not solved explicitly, but ions are assumed to be present, providing charge neutralization of the layer. A program for these solutions is meant to be used for extensive parameter studies. In particular, the form and time behavior of the vacuum fields can be varied, as can the method of injection. There is a great variety of quantities that can be printed out or plotted at any given time step. Usually, one concentrates on dependent variables, such as the current density, that are functions of the spatial coordinates r and z. This, together with the magnetic field, describes the solution to the self-consistent field problem. The boundary conditions, other computational details, and sample results are contained in a recently published paper (J. Computational Phys., 1:29(1966)). (TSS)

44063 (NASA-SP-153, pp 163-89) MAGNETOHYDRODYNAMIC PLASMA CALCULATIONS. Roberts, K. V. (California Univ., La Jolla, San Diego).

Some of the problems which are encountered in simulating the behavior of plasma devices on the computer are briefly outlined. Most of them only become serious when two- or three-dimensional calculations are attempted, and one of the critical problems lies in the treatment of the advective term. A conservative Eulerian difference scheme is described. The MHD conservation laws can be given an integral, space-time representation, which is reflected in the mesh to be used, and in the definition of the variables to be stored in the machine. The advective term in each equation is handled by a fourth-order method. (auth)

44064 (NASA-SP-153, pp 191-6) COMPUTER SIMULATION OF THE THETA PINCH. Oliphant, Thomas A. (Los Alamos Scientific Lab., N. Mex.).

A basic numerical method for the computer simulation of the straight cylinder theta pinch is described. (M.O.W.)

44065 (NASA-SP-153, pp 199-216) NONLINEAR HIGH FREQUENCY-PLASMA INTERACTION IN A MAGNETIC MIRROR. Canobbio, E.; Collet, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A large-amplitude electromagnetic field accelerates the electrons of a beam injected into a mirror region. The ion motion is produced by the self-consistent axial space charge field. When the electron velocity exceeds a critical value, steady electrostatic shock waves appear. Analytical and numerical computations are presented. (auth)

44066 (NASA-SP-153, pp 217-35) COMPUTER SIMULATION OF THE BEAM-PLASMA INTERACTION. Davis, J. A.; Bers, A. (Massachusetts Inst. of Tech., Cambridge).

The effects of longitudinal plasma density gradients on the steady-state nonlinear beam–plasma interaction were investigated by computer modeling with a finite-diameter beam in an infinite plasma. The gradients and finite beam diameter seem necessary to explain the relatively narrow collected beam velocity distribution observed experimentally. For a given plasma density profile and beam density, the interaction becomes less intense as the total plasma density increases. (auth)

44067 (NASA-SP-153, pp 237-64) NUMERICAL SOLUTION FOR 1,5-DIMENSIONAL, TIME-DEPENDENT MAGNETOHYDRODYNAMIC PROBLEMS. Hain, Klaus (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center).

In some problems such as θ pinches with parallel fields, the overall structure is governed by a strong magnetic field. The Alfven speed V_A across the field lines is so high that the transversal time $t = R/V_A$, where the radius R is small compared with a characteristic time t_c of the system, so that a quasi equilibrium can be reached in the time interval t_c. The dimension perpendicular to the field is therefore counted as 0.5 dimension. In contrast, the full MHD equations apply parallel to the field lines. In particular, the behavior of shock waves parallel to the magnetic field is studied under various conditions. (M.O.W.)

44068 (NASA-SP-153, pp 269-73) THETA-PINCH SHOCK IMPLOSION CALCULATIONS BY MODEL SIMULATION OF COLLISIONLESS ION VLASOV EQUATION. Kilb, R. W. (General Electric Co., Schenectady, N. Y. Research and Development Center).

Computations describing the implosion phase of high-voltage low-density theta pinches are carried out by using the collisionless Vlasov equation for the ions, and using the fluid equation for adiabatic electrons. The calculations are on a time scale long compared to the electron cyclotron time, but short compared to the ion cyclotron time. The equations are reduced to a set of equivalent cylindrical plasma sheets. The calculations show that the nonadiabatic ion heating in very low-bias, negative-bias, and positive-bias theta pinches results from ion interaction with rapidly fluctuating electric and magnetic fields inside the plasma, and with the rapidly converging outside surface of the plasma. The mean ion energy was 1 keV at two microseconds for very low bias and negative 1.5-kG bias, while it was only 0.6 keV for positive 1.5 kG. For very low bias the ion pressure is nonisotropic with $P_{rr} \gg p_{\theta\theta}$, and the density tends to peak on the axis. These effects do not occur for +1.5-kG and −1.5-kG bias. All three cases show plasma mass rotation, with the outside portion counter-rotating with respect to the inner portion in order to conserve overall zero angular momentum. This rotation appears to be related to finite Larmor effects. Comparisons are made with experimental results. (auth)

44069 (NASA-SP-153, pp 369-74) NUMERICAL EXPERIMENTS ON THE NONLINEAR KROOK MODEL OF THE BOLTZMANN EQUATION. Chu, C. K. (Columbia Univ., New York. Dept. of Mechanical Engineering).

Work that has proven interesting in one-dimensional time-dependent problems in neutral gases, in which shock waves occur, is reviewed. (M.O.W.)

44070 (NP-17050) THE STEEPENING OF MHD SWITCH-ON SHOCK WAVES IN A PLASMA. Green, B. J. (Sydney Univ. (Australia). School of Physics). July 1967. 11p. (TR-20). Dep. CFSTI.

The simple model which describes the formation of a shock wave from the motion of a series of small amplitude waves, appears to fail for the case of the MHD switchon shock in a plasma. It is shown here that such a model is indeed adequate. The confusion arises because it is possible (in principle) to launch a large-amplitude transverse MHD wave which does not steepen in a compressible plasma. (auth)

44071 (NYO-3782-1) PROPERTIES OF THE HIGH BETA PLASMA STATE. Progress Report, November 1, 1966–July 31, 1967. [Auer, Peter L.,] (Cornell Univ., Ithaca, N. Y.). Aug. 1, 1967. Contract AT(30-1)-3782. 17p. Dep. CFSTI.

An adiabatic treatment of the Vlasov equation is given. A solution for the exact dispersion relations for magneto-compressional waves is given. (M.O.W.)

44072 THE THEORY OF STATISTICAL PARTICLE MIXTURE EQUILIBRIUM. II. Artym, R. I. (Moscow Inst. of Power Engineering). Teplofiz. Vys. Temp., 5: 574-83(July-Aug. 1967). (In Russian).

A simple method is suggested for obtaining equations of state based on the segregation of first-order terms in the expression of configuration integrals. The method was used for developing formulas for the free energy and equations of state of a mixture consisting of neutral and charged particles. (tr-auth)

44073 PROPAGATION AND DISPERSION OF IONIC WAVES. APPLICATION TO THE LANGMUIR PROBE. Gresse, Herve (Office National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Rech. Aerosp., No. 115, 21-7(1966). (In French).

The problem of ionic wave dispersion and propagation is based on the solution of a partial differential equation similar to Burgers' equation. The one-dimensional problem is studied, with results for monokinetic ions and a Maxwellian distribution emphasized. Wave deformation is examined, and numerical solutions graphed; in addition, an analytical study of potential oscillations is made. An application is made of the problem of the piston under Bohm's condition, and is then generalized to the Langmuir probe by consideration of an approach to the extension of the results to 3 dimensions. (BBB)

44074 RELAXATION OF ANISOTROPIC PLASMAS. Lehner, G. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 206: 284-92(1967).

The relaxation of anisotropic plasma due to collisions between two kinds of particles is discussed on the basis of the Fokker–Planck equation, i.e., collective interactions are not taken into account. An initially elliptic distribution is assumed to remain elliptic during the relaxation process. This is the only approximation made; i.e., the usual restriction to small anisotropy is avoided. (auth)

44075 DISPERSION RELATION IN COMPRESSIBLE PLASMA. Wu, Yung-kuang (Southeastern Massachusetts Technological Inst., North Dartmouth). Radio Sci., 2: 1019-29(Sept. 1967).

The Maxwell–Euler equations are reformulated through linear operator and generalized transform techniques into an equivalent matrix integral equation. The dispersion relation is obtained from the kernel of this integral equation for a homogeneous, anisotropic, and compressible electron–fluid plasma. Some illuminating graphs showing the propagation constants as functions of the normalized plasma frequency are developed analytically to study the dispersion relation. These kinds of graphs are usually plotted from the limited amount of numerical data available in the literature (e.g., Ginzburg, 1961). A Clemmow–Mullaly–Allis type of diagram for the compressible plasma is sketched from these graphs. Actually, dispersion curves are obtained which are inversely related to the wave normal surfaces calculated by Allis, Buchsbaum, and Bers (1963). A proper terminology for the three types of waves involved in an electron plasma is also introduced. (auth)

44076 ELECTROMAGNETIC REFLECTIVITY OF NON-UNIFORM JET STREAMS. Kritikos, H. N.; Lee, K. S. H.; Papas, C. H. (California Inst. of Tech., Pasadena). Radio Sci., 2: 991-5(Sept. 1967).

The reflection coefficient of a plane monochromatic electromagnetic wave incident on an idealized laminar plane stratified jet stream is determined. This is accomplished by applying the principle of invariant imbedding to derive a differential equation for the reflection coefficient. The differential equation which is of the Riccati type is solved approximatley for the case of a jet stream with a parabolic velocity profile. (auth)

44077 ON RELAXATION IN THE COULOMB QUASI-EQUILIBRIUM PLASMA. Logvinov, V. V. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 119-23(Jan.-Feb. 1967). (In Russian).

A method is given for resolving two problems on relaxation of directed velocities and temperatures in Coulomb collisions in a quasi-equilibrium plasma (plasma in which all components have a Maxwellian distribution of particle velocities, but various velocity and temperature directions). The problem was previously resolved by direct calculations of collision integrals according to Landau but without taking into account plasma polarization. Results are given of calculation of integrals of pulse and energy variations of an arbitrary component a due to the collisions between a particles and other particles in the plasma and considering various velocity directions of the components. Calculations are also given for the effective electron collision frequency describing the influence of Coulomb collisions on fast alternating processes in plasma during electromagnetic wave propagation. (R.V.J.)

44078 BRANCH-CUT CONTRIBUTION TO THE LONGITUDINAL ELECTRIC FIELD IN RELATIVISTIC PLASMAS. Zachary, W. W. (Naval Research Lab., Washington, D. C.). Nuovo Cim. (10), 51B: 71-81(Sept. 11, 1967).

The branch-cut contribution to the longitudinal electric field in a relativistic Maxwellian plasma is evaluated in the long-time limit by a procedure which does not depend upon the Laplace transformation method. The analytic-continuation difficulty inherent in previous work in this field is thereby eliminated. (auth)

44079 INVESTIGATION OF THE AZIMUTHAL INHOMOGENEITY OF THE PLASMA IN THE HEMOPOLAR DEVICE. Drobyshevskii, E. M.; Rozov, S. I.; Studenkov, A. M. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 37: 979-83(May 1967). (In Russian).

In earlier work (ZhTF, 37, No. 2, 322, 1967) with the homopolar device it was found that the azimuthal current density was only about twice the radial current density, although under the conditions of the experiments (magnetic field strength, 200 to 2500 Oe; current, 2 to 4 A; pressure, 0.1 to 1.0 torr) a much higher ratio of azimuthal to radial current density should be expected. The possibility was considered that this discrepancy is due to the presence of radial current channels that rotate with the gas "like spokes in a wheel." A fixed probe within the plasma, a photomultiplier recording luminous radiation from the plasma, and direct high speed cinematography all revealed the presence of just one rotating current channel. The theory of J. Eniger of the motion of a plasma front through a neutral gas in crossed fields was employed to calculate the rotation velocity of current "spoke" in the homopolar device. The theoretical velocity was found to be considerably higher than the observed velocity. This discrepancy is ascribed to lag of the cathode spot behind the motion of the current channel. Irregular voltage pulsations with a mean frequency about an order of magnitude higher than the rotation frequency of the plasma were observed. It is suggested that these pulsations may be due to repeated destruction of the cathode spot and formation of a new one. (ATD)

44080 MODELING FLOW PROCESSES OF GAS JETS BY MEANS OF PLASMA BURSTS. Eremin, B. G.; Miller, M. A.; Poluyakhtov, B. K. (Gorky State Univ., USSR). Zh. Tekh. Fiz., 37: 987-89(May 1967). (In Russian).

Some aspects of the supersonic flow of gases were studied experimentally by shooting plasmas from electrodynamic plasma guns through nozzles. Advantages of the method are the ease of achieving high velocities and very high pressure ratios, and the availability of plasma diagnostic techniques. A disadvantage is the fact that the plasma burst increases the pressure in the experimental chamber, but this disadvantage can be partly overcome by employing a large chamber. Three conical nozzles were investigated, of which one produced a normal subsonic flow and the other two produced supersonic jets with Mach numbers of 1.8 and 3.3, respectively. In the case of each supersonic jet the ratio of the pressure in the nozzle to the initial pressure in the chamber (0.1 mm Hg) was 1.8×10^3. The Mach disk was clearly evident on the photographs and its position agreed with the calculated position within the accuracy of the measurements. (ATD)

44081 VARIATIONAL PRINCIPLE FOR SYMMETRIC MAGNETOHYDRODYNAMIC FIELDS. Ermakov, F. A. (Inst. of Terrestrial Magnetism, Ionsphere, and Radio Wave Propagation, Moscow). Zh. Tekh. Fiz., 37: 989-90(May 1967). (In Russian).

It is shown that the magnetohydrodynamic equation curl $B \times B - 4\pi$ grad $p = 0$, which can be derived in the three-dimensional case from the Lagrangian $L(\alpha,\beta) = B \cdot B - 8\pi p$ of H.Grade (Phys. Fluids, 7: 1283(1964)), where α and β are potentials in terms of which the solenoidal field B is given by the local Euler representation $B = \text{grad}\beta \times \text{grad}\beta$, can be derived in the two-dimensional case in which everything is independent of one of the coordinates (x^3) of the general coordinate system x^1, x^2, x^3 from the Lagrangian $L(\alpha) = B_1B^1 + B_2B^2 - B_3B^3 - 8\pi p$, provided p and B_3 depend only on α, i.e., provided the current surfaces coincide with the magnetic surfaces. As an elementary application of this Lagrangian it is shown that the force-free field configuration minimizes the difference between the poloidal and toroidal energies of the field. (ATD)

44082 SOME RESULTS OF AN INVESTIGATION OF HIGH-VOLTAGE PULSED DISCHARGES IN LONG TUBES. Kostin, V. N.; Vinokurov, N. I.; Belous, V. V. (Kharkov State Univ.). Zh. Tekh. Fiz., 37: 873-6(May 1967). (In Russian).

Pulsed discharges across 4- to 75-cm gaps in hydrogen at pressures from 0.20- to 100-mm Hg were investigated. Auxiliary experiments showed that the delay T_d between the voltage rise and the appearence of appreciable current did not depend on the presence of a hot cathode; from this it is concluded that under the conditions of the experiments T_d represented the true time of development of the initial stage of the discharge. As a function of pressure, T_d had a minimum value of the order of 1 μsec at a pressure p_m that ranged from 0.5-mm Hg for the 75-cm gap to 3-mm Hg for the 4-cm gap and rose rapidly to values of the order of 700 μsec as the pressure p increased or decreased from p_m. The pd product (d is the gap length) for a fixed value of 10 μsec for T_d with $p > p_m$ was nearly constant, and equal to 240 to 280-mm Hg cm. The formation time T_f (the duration of the rapid current rise from the first appearance of appreciable current until the breakdown of the gap is fully established) had a maximum value of about 3 μsec at a pressure of about 2-mm Hg. This maximum of T_f was associated with the appearance of a step on the current oscillogram. These phenomena are interpreted in terms of the pressure dependence of the ionization coefficient α. Brief bursts of approximately 3-MHz oscillations were also ob-

served during the development of the discharge. The cause of these oscillations was not determined. (ATD)

44083 INVESTIGATION OF THE CURRENT LAYER AND THE ACCELERATION OF PLASMA IN A COAXIAL PLASMA GUN. Kalmykov, A. A.; Timofeev, A. D.; Pankrat'ev, Yu. I.; Artsebashev, V. I.; Khizhnyak, N. A. Zh. Tekh. Fiz., 37: 877-87(May 1967). (In Russian).

The magnetic fields within the gun were measured with 3 mm diameter pickup coils protected from the discharge with quartz tubes; the electric fields were measured with double floating probes, oscillograms of the discharge current were recorded; high speed photographs of the discharges were recorded through a longitudinal slit in the outer electrode with the aid of an electron-optical image converter; and the plasmas were analyzed with a mass spectrometer. The characteristics of the discharge were investigated as functions of the delay time between the admission of the gas and the discharge. Many experimental results are discussed and a few illustrative oscillograms are presented, but very few actual data are given. The general conclusion is reached that the theory gives, on the whole, a qualitatively good description of the plasma acceleration process. More specific conclusions are : (1) A current layer is formed within the gun for a rather wide range of values of the various parameters; (2) At low gas densities most of the current flows in the current layer, and at high gas densities most of the current flows in the body of the plasma; (3) There are two regimes of plasma acceleration, depending on the ratio of the current layer velocity to the Alfven velocity; (4) A longitudinal electric polarization field arises in the current layer, the strength of which is related to the current in the layer and the plasma density in qualitative accordance with the predictions of the theory; (5) In the slow regime the acceleration of the plasma is due to the action of the longitudinal electric polarization field, as is confirmed by the fact that ions of different masses receive the same energy; and (6) the fast ions are also accelerated by an electrostatic mechanism, but by a different one. (ATD)

44084 SKIN EFFECT IN AN INTENSE SUPERHIGH-FREQUENCY DISCHARGE. Motornenko, A. P.; Belousov, E. V. (Inst. of Radiophysics and Electronics, Kharkov). Zh. Tekh. Fiz., 37: 903-5(May 1967). (In Russian).

The transmission and absorption of 3-cm microwaves by helium and argon plasmas were investigated. The plasmas were produced in a 13×2 mm^2 rectangular quartz tube which traversed a rectangular waveguide perpendicular to the large wall of the waveguide and with its large wall parallel to the axis of the waveguide. The transmission and absorption of the microwaves by the plasma were measured as functions of the gas pressure in the discharge tube, which was varied from about 0.2 to 40 mm Hg, and as functions of the microwave power, which was supplied either steadily or in 0.2-μsec pulses with powers up to 40 kW. With a microwave power of 17 kW the transmission of microwaves by the plasmas decreased rapidly with increasing gas pressure until, at a pressure of about 2-mm Hg, the plasmas were practically opaque; with further increase of the pressure the plasmas began again to transmit an appreciable fraction of the incident microwave power. At high gas pressures the fraction of the incident power absorbed was independent of the microwave power, and at low gas pressures the absorption increased with increasing microwave power. These phenomena are discussed briefly in terms of the formation of a skin layer. Under conditions of high absorption, the radiation from the portion of the plasma toward the microwave source contained preferentially spectral lines with high excitation potentials, and the radiation from the portion of the plasma away from the microwave source contained preferentially lines with low excitation potentials. It is concluded that the formation of a skin layer can be a serious obstacle to the achievement of high electron temperatures with the aid of microwaves, and that it may prove useful in spectroscopy for the simultaneous excitation of sprectral lines with low and high excitation potentials. (ATD)

44085 DISTRIBUTION OF ION CURRENT DENSITY ON THE CATHODE IN A PENNING DISCHARGE. Rudnitskii, E. M. Zh. Tekh. Fiz., 37: 927-31(May 1967). (In Russian).

The ion current distribution on the cathodes in low pressure Penning discharges was measured in order to shed some light on the operation of ion pumps. The experimental discharge cell had a 12-mm-diameter 16-mm-long stainless steel cylindrical anode and two large plane titanium cathodes, each mounted 6 mm from the anode and perpendicular to its axis. One cathode could be moved in its own plane and carried a 0.5-mm-diameter probe electrode, which was in the plane of the cathode proper and was insulated from it. The ion current distributions were obtained by recording the currents to the two cathodes and to the probe electrode with the probe electrode in different radial positions. Most of the data presented were recorded at a pressure of 6×10^{-6} torr, an anode potential of 3 to 7 kV, and a magnetic field strength of 800 to 2350 Oe. At low magnetic field strengths the current density was maximum at the center of the cathode and decreased monotonically with increasing distance from the axis. When the magnetic field strength was increased there developed an annular region of low or zero ion current, and in the strongest fields the current was zero or low at the center of the cathode. The efficiency of the pumping action due to sputtering of material from one of the cathodes onto the other with entrapment of gas molecules is also discussed briefly. (ATD)

44086 POPULATIONS OF HYDROGEN LEVELS IN A RECOMBINING PULSED PLASMA. Gudzenko, L. I.; Mashachun, A. T.; Shelepin, L. A. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 833-5(May 1967). (In Russian).

A computer program has been written for the calculation of the time dependence of the population densities of the first ten excited states of hydrogen atoms in a plasma that is not in equilibrium and the program has been employed to compute the population densities in plasmas with electron densities of 10^{13}, 10^{14}, 10^{15}, and 10^{16} cm^{-3} that were initially in equilibrium at an electron temperature of 2 eV and were suddenly cooled to an electron temperature of 0.05, 0.1, 0.2, or 0.5 eV. The program includes the effects of collisions of the first and second kinds, ionization, radiative recombination, three body recombination and spontaneous radiative transitions, but it does not include the effects of de-excitation in collisions with heavy particles or heating of the electrons in collisions of the second kind. The calculations showed that the criterion of McWhirter and Hearn (Proc. Phys. Soc., 82: 641(1963)) for the validity of the "steady drain" approximation (that the sum of the population densities of all the excited states be smaller than the electron density) is a reasonably good one. It was found that the initial population inversion rapidly disappears (within 10^{-9} sec in the case of a plasma with an electron density of 10^{16} cm^{-3} after the electron temperature has been suddenly reduced from 2 to 0.1 eV) but later reappears (after 3×10^{-8} sec in the above case). Two of the authors (Dokl. Akad. Nauk SSSR, 160: 1296(1965)) previously suggested that population inversion might be achieved in a gaseous laser by suddenly cooling the free electrons from a temperature of 2 eV to 0.1 eV in a time of the order of 10^{-8} sec; the present calculations indicate that it would be adequate to cool the electrons in stages, cooling them first to 0.2 to 0.5 eV in 10^{-4} to 10^{-5} sec and then to 0.1 eV in 10^{-7} to 10^{-8} sec. (ATD)

44087 THEORY OF SURFACE WAVES ON A PLASMA. Alanakyan, Yu. R. Zh. Tekh. Fiz., 37: 817-21(May 1967). (In Russian).

The propagation of electromagnetic surface waves on the plane boundary between a uniform plasma and a linear medium (or the vacuum), taking into account in the first approximation the effect of the electric field of the wave on the density distribution in the plasma is discussed. The calculations are based on Maxwell's equations, the usual expression for the dielectric constant of a uniform plasma (with collisions neglected), and the equation given by Getmantsev and Denisov (Geomagn. Aeronomiya, 2: 691(1962)) for the electron density in the plasma as a function of the strength of the alternating electric field of the wave. The dispersion equation is derived and discussed. It is shown that surface waves can propagate on the plane plasma–vacuum boundary provided the square of the wave frequency does not exceed half the square of the electron Langmuir frequency, and the electric field strength of the wave does not exceed a certain value for which an equation and graphs are given. If these conditions are not satisfied, the disturbance does not remain confined to the plasma surface, but propagates into the body of the plasma. (ATD)

44088 ULTRASOUND IN AN ELECTRO-ION PLASMA. Bodganov, A. V. Uch. Zap. Mosk. Obl. Pedagog. Inst., 147: 193-9(1964).

Longitudinal oscillations of a homogeneous plasma were investigated. An additional term, describing the action of the ultrasonic field on the charged particles, is introduced into the kinetic equation. The investigation was carried out in a linear nonisothermal approximation with account of the collisions of the charged particles (electron–electron and ion–ion). The theory of ionic oscillations is constructed in full analogy with the theory of electronic oscillations, when the condition $T_e \gg T_i$ is satisfied for the temperatures of the electrons and the ions, and when the rapid electrons produce a background that compensates for the average charge of the ions. Expressions are obtained for the amplitudes of the charge density as functions of the frequency and amplitude of the ultrasound potential. The resonant character of the ultrasonic excitation of the plasma near the frequencies of the natural oscillations of the electrons ν_e and of the ions ν_i, which for a plasma in a neon gas discharge tube amount to $\nu_e \approx 9 \times 10^9$ cps and $\nu_i \approx 4.6 \times 10^6$ cps, is demonstrated. (ATD)

44089 RAREFIED PLASMA MOTION IN MUTUALLY PERPENDICULAR ELECTRIC AND MAGNETIC FIELDS. Fishgoit, V. V. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza, No. 4, 155-8 (July-Aug. 1967). (In Russian).

Steady flow of hydrogen ions and electrons in mutually perpendicular electric and magnetic fields is treated, without considering particle collisions and thermal motion. Analytical expressions are developed for parameters of motion. (R.V.J.)

44090 THE ELECTRIC ARC ORIGINATING FROM AN INDUCED ELECTRIC FIELD UNDER STEADY-STATE CONDITIONS. II. Giovanelli, Raffaele. Riv. Ing., 981-1001(Nov. 1966). (In Italian).

A description is given of the electromagnetic field in an induction-type plasma generator starting from the Maxwell equations and the heat-conservation equations. A homogeneous and isotropic medium is considered, together with a fixed conductor run through by a known current variable with time. (IAA)

44091 FLUCTUATIONS AND SCATTERING OF ELECTROMAGNETIC WAVES IN A PLASMA LOCATED IN AN EXTERNAL ELECTRIC FIELD. Angeleiko, V. V.; Akhiezer, I. A. (Kharkov State Univ.). Zh. Eksp. Teor. Fiz., 53: 689-98(Aug. 1967). (In Russian).

Fluctuations and scattering of electromagnetic waves in a partially ionized plasma located in an external electric field are studied. It is shown that if the frequency of the collisions between charged and neutral particles is small, $\nu \ll \Delta\omega$ ($\Delta\omega$ is the fluctuation frequency), the correlation functions possess sharp maxima at the ion-acoustic oscillation frequencies. As a result ion-acoustic satellites appear in the scattered radiation spectrum when an electromagnetic wave passes through the plasma. At not very large values of the external electric field strength the intensity of these satellites increases linearly with the field strength. With approach of the electric field to the critical value the intensity of the satellites sharply increases, and approaches infinity (within the framework of the linear theory). Fluctuations and combination scattering of electromagnetic waves in a weakly ionized plasma are also investigated and the problem of applicability of the results to other plasma media (semiconductors, electrolyte solutions) is discussed. (auth)

44092 CHERENKOV EMISSION OF ALFVEN WAVES. Dokuchaev, V. P. (Gorky State Univ.). Zh. Eksp. Teor. Fiz., 53: 723-31(Aug. 1967). (In Russian).

Cherenkov emission of Alfven waves by a force source moving uniformly and rectilinearly at an arbitrary angle with respect to a magnetic field is considered. Use is made of an analogy with the emission of transverse waves in a system of parallel elastic strings along which the perturbation force moves. The simplest electric current systems which can excite Alfven waves are presented. Expressions are derived for the perturbation fields. The reactive forces of the radiation are determined. (auth)

44093 THEORY OF FLUCTUATION LEVELS IN DISORDERED SYSTEMS. Lifshits, I. M. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 53: 743-58(Aug. 1967). (In Russian).

The energy spectrum of a particle in the field of a disordered system of scattering centers is investigated. A classification of such spectra based on the "intensity" of a single scattering center is presented and the structure of the spectrum in some limiting cases is elucidated. It is shown that for low "intensity" centers the energy levels located at the left of the renormalized spectrum boundary (defined by the mean potential acting on the particle) outside its narrow smearout region are of a fluctuation nature and due to macroscopic fluctuations of the scatterer density. A complete and consistent theory of such fluctuation levels is developed which is based on a statistical description of the scatterer system. The spectral density $\nu(E)$, form of the wave functions for the fluctuation levels E and the shape of the density fluctuations on which the levels originate, are found. It is shown that for sufficiently low scatterer concentrations, c, a spectral density $\nu(E,c)$ singularity line is located near the renormalized spectrum boundary in the E,c plane. This line separates states created by weak "long wave" concentration fluctuations from states corresponding to high concentration local fluctuations. (auth)

44094 NOISE IN A TURBULENT PLASMA. Lin, D. N.; Skoryupin, V. A. Zh. Eksp. Teor. Fiz., 53: 463-72(Aug. 1967). (In Russian).

Results are presented of an investigation of the electromagnetic radiation from a plasma during turbulent heating by a current. It is demonstrated that the intensity of the radiation depends on the magnitude of the longitudinal electric field, as well as on its distribution along the length of the plasma column. The spectral composition of the radiation and its dependence on the plasma density in the trap is investigated. The degree of plasma turbulence is estimated on basis of the magnitude of the diamagnetic effect and anomalous resistance. (auth)

44095 TRANSFORMATION OF THE ENERGY ACCUMULATED IN AN ACTIVE MEDIUM INTO THE ENERGY OF A LONGITUDINAL WAVE IN A PLASMA. Krasovitskii, V. B. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 53: 573-8(Aug. 1967). (In Russian).

The possibility of employing an excited active medium (three-level system) for amplifying plasma waves is investigated. It is shown that the energy confined in the medium can be transformed into the energy of a plasma wave with a prescribed phase velocity. The conditions for such transformation are determined. (auth)

44096 EMISSIVITY AND ABSORPTION COEFFICIENT OF A HOMOGENEOUS NONEQUILIBRIUM PLASMA. Bel, N.; Mangeney, A. (Institut d'Astrophysique, Paris. Observatoire de Paris, Meudon, France). Ann. Astrophys., 30: 649-57(July-Aug. 1967).

Starting from a perturbation approach to the Liouville equation for particles interacting with an electromagnetic field, the general expressions for the emissivity and the absorption coefficient are established. These expressions which are valid to all orders in the electromagnetic charge, relate the emissivity and the absorption coefficient with the micro-current correlation tensor and the conductivity tensor. (auth)

44097 ASSUMED BOUNDARY CONDITIONS AT AN INTERFACE BETWEEN A DIELECTRIC AND A COMPRESSIBLE PLASMA. Wait, J. R. (Harvard Univ., Cambridge, Mass.). Electron. Lett., 3: 317-18(July 1967).

Some remarks are made concerning two assumed boundary conditions at the interface between a dielectric region and a compressible plasma. It is indicated that Fedorchenko's double Laplace integral formulation, which invokes causality, is equivalent to the assumption of continuity of the normal electric field. In general, this differs from results derived on the basis of an assumed rigid boundary. It is shown that both expressions for the reflection coefficient in the dielectric region have the same form, but the temperature correction is different. Without appeal to the physics of the sheath, there is no reason to choose one condition over the other. (auth) (UK)

44098 COLLISIONLESS DAMPING OF LARGE-AMPLITUDE PLASMA WAVES. Malmberg, J. H.; Wharton, C. B. (General Atomic Div., General Dynamics Corp., San Diego, Calif). Phys. Rev. Lett., 19: 775-8(Oct. 2, 1967).

Preliminary results are reported of an experiment designed to compare the collisionless damping of small- and large-amplitude waves. (auth)

44099 ASYMPTOTIC SOLUTION OF OBLIQUE WAVES IN INHOMOGENEOUS VERTICALLY MAGNETIZED PLASMA. Rao, S. S.; Unz, H. (Univ. of Kansas, Lawrence). Electron. Lett., 3: 184-5(May 1967).

A method for finding higher-order asymptotic solutions, as compared with the well known WKBJ approximation, is given for oblique electromagnetic waves in an inhomogeneous anisotropic plasma with a vertical magnetostatic field. (auth) (UK)

44100 WAVE PROPAGATION IN A MOVING PLASMA. Chawla, B. R.; Unz, H. (Univ. of Kansas, Lawrence). Electron. Lett., 3: 244-5(June 1967).

Comments are made on previous work by Scarf [Amer. J. Phys., 29: 101-7(1961)] on wave propagation in a moving plasma, and some new results added. (auth)

44101 LONGITUDINAL RESONANCES OF PLASMA SURFACE WAVES IN NOBLE GASES. Zhelyazkov, I.; Stoytchev, T.; Nikolov, N. (Sofia Univ.). Electron. Lett., 3: 253-4(June 1967).

The excitation and propagation of axially symmetric surface plasma waves along a plasma column were investigated at frequencies from 100 to 200 MHz, and obtained dispersion curves for such waves in gas-discharge plasmas of He, Ne and Kr at pressures of 0.03 to 0.20 torr. The results are in good agreement with the theory of surface waves in quasistatic approximation. (auth) (UK)

44102 CHERENKOV RADIATION IN A MAGNETOIONIC MEDIUM. Seshadri, S. R. (Sylvania Electronic Systems, Waltham, Mass.). Electron. Lett., 3: 271-3(June 1967).

For certain values of parameters, a point charge moving with uniform velocity parallel to the magnetostatic field in an unbounded magnetoionic medium excites two modes. In a recent investigation Kurdyumov has concluded that, of these two modes, one is associated with emission of energy and the other with absorption. Theoretical arguments, as well as experimental evi-

dence, are advanced in order to establish that both the modes, contrary to the conclusion of Kurdyumov, are associated with emission of energy. (auth) (UK)

44103 T.W.T.-TYPE RADIATION FROM A UNIFORMLY MOVING CHARGE IN AN ISOTROPIC PLASMA ENVIRONMENT. Seshadri, S. R. (Sylvania Electronic Systems, Waltham, Mass.). Electron. Lett., 3: 163-4(Apr. 1967).

The characteristics of the travelling-wave-tube-type radiation produced by a point charge moving with uniform velocity along the axis of an infinite cylindrical cavity of free space in an otherwise unbounded, isotropic, cold and homogeneous plasma are investigated. For sufficiently small radius of the free-space column, the frequency of the emitted radiation is close to the plasma frequency, and the radiated energy is of significant strength and progresses in a direction opposite to that of the motion of the charge. (auth) (UK)

44104 PROPAGATION OF ION WAVES IN WEAKLY IONIZED GASES. Sessler, G. M.; Pearson, Gary A. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 162: 108-16(Oct. 5, 1967).

Theoretical and experimental results are presented on the propagation of longitudinal ion waves in weakly ionized gases in a frequency range extending from considerably below to well above the ion plasma frequency. The theory describes propagation in a uniform plasma on the basis of kinetic equations. First, a dispersion relation is derived and solved for the complex propagation constant; this is appropriate if the damping is weak. Second, the spatial dependence of the phase and amplitude of the disturbance excited by a pair of grids is calculated; when the damping is not weak, the amplitude does not decay exponentially with distance. The measurements are performed with grid-excited ion waves at frequencies between 0.1 and 10 MHz in hydrogen, nitrogen, argon, and krypton rf discharges with charged-particle densities of about 10^9 cm^{-3} and electron temperatures of the order of 50,000°K. At frequencies well below the ion plasma frequency ω_i, the phase velocity is found to be frequency-independent and is given by the Tonks–Langmuir speed. At these frequencies, the attentuation is proportional to the neutral gas pressure and is therefore primarily caused by ion–neutral collisions. At frequencies approaching ω_i, the attentuation is higher than expected from collisions, and the excess is attributed to ion Landau damping. Theory and experiment agree well at ω smaller than ω_i. For frequencies greater than ω_i, the phase velocity increases with frequency, but not as much as expected on the basis of a Maxwellian velocity distribution of the ion gas. Moreover, the ratio of imaginary to real part of the propagation constant, which is found to decrease slightly with frequency, is much smaller than expected from the theory. Better agreement between experiment and theory in this frequency range can be obtained by assuming the ionic velocity distribution to decrease more rapidly at high velocities than a Maxwellian distribution. Non-Maxwellian velocity distributions of this kind are actually expected under the conditions of the experiment. The data reported furnish the first experimental evidence of ion-wave propagation at frequencies greater than ω_i. (auth)

44105 MEASURED INDEX OF REFRACTION FOR ARGON PLASMA. Hug, W. F.; Evans, D.; Tankin, R. S.; Cambel, A. B. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 162: 117-22(Oct. 5, 1967).

The index of refraction of argon plasma in the temperature range 9500 to 19,000°K was measured at a wavelength of 6328 Å. A helium–neon laser was used as the light source for a Mach–Zehnder interferometer. A modified commercial plasma jet and a free-burning arc were used as plasma sources. The index of refraction was calculated using the Slater screening-constant method. The measured index of refraction lies between the theoretical curve that considers contributions from only ground-state atoms and free electrons and the curve that considers excited electrons as free. There appears to be a lowering of the ionization limit to a principle quantum number of 5 for the atom of 16,000°K, compared with Olsen's value of 6. (auth)

44106 KINETIC EQUATION FOR DRIFTED ELECTRON PLASMA. Tzoar, N. (Bell Telephone Labs., Whippany, N. J.). Phys. Rev., 162: 123-7(Oct. 5, 1967).

The kinetic equation for a plasma consisting of ions and drifted electrons under the influence of an electric field is derived, neglecting electron–electron correlations. The high-frequency resistivity is calculated and its dependence on the drift velocity v_D is obtained. Resistive instability was found to occur for $v_D \cong 1.4v_{th}$, where v_{th} is the steady-state electron thermal velocity. (auth)

44107 RELATIVISTIC PERFECT GAS IN AN EXTERNAL FORCE FIELD. Hakim, Remi (Temple Univ., Philadelphia). Phys. Rev., 162: 128-33(Oct. 5, 1967).

The distribution function of a relativistic perfect gas embedded in an external force field is derived in the case of an electromagnetic or a classical mesonic field. As a consequence, the corresponding forms of the relativistic Debye–Hückel laws are obtained in a manifestly covariant way. The covariant Debye–Hückel law may lead to simple kinetic equations for a relativistic plasma. (auth)

44108 HIGH FREQUENCY GAS DISCHARGE NOISE. Messenger, R.; van der Ziel, A. (Univ. of Minnesota, Minneapolis). pp 284-90 of Twenty-Seventh Annual Conference on Physical Electronics, Cambridge, Mass., Mar. 20–22, 1967. Cambridge, Mass., Massachusetts Institute of Technology, 1967.

See CONF-670320.

By representing the bulk plasma of a gas discharge by a distributed R–G–C line, the frequency dependence of the impedances proposed by Hanson and van der Ziel in their equivalent circuit for gas discharges can be explained. This distributed line also explains quite well the behavior of the noise temperature at high frequencies under various probe bias conditions. All apparent high-frequency noise sources can be explained on the basis of this representation. (auth)

44109 NATURE OF A MOVING PLASMA, OBTAINED IN AN ELECTRIC DRIVEN SHOCK TUBE. Chutov, Yu. I. (Kiev State Univ.). Ukr. Fiz. Zh., 12: 1153-9(July 1967). (In Russian).

By means of experiments the dependence of the glow spreading velocity on the initial pressure (p_0 = 0.5 to 2 mm Hg) and on the battery voltage of condensers (V = 1 to 4 kV) was investigated in an electric driven shock tube filled with hydrogen. The discharge current broke off at the end of the first half-period, the duration of which is 10 μs. The spatial distribution of the discharge current was registered with a magnetic probe. A temporal change of the charge concentration at different points along the shock tube axis was studied by the Stark broadening of the Hp line. The dependence of the charge concentration on the initial pressure of hydrogen was determined inside a discharge device. The results of the experiments show that gasokinetic pressure plays a decisive role in throwing plasma out of the discharge device and that the moving plasma is a currentless flow of a discharged plasma. (auth)

44110 ON WAVE EXCITATION IN PLASMA BY EXTERNAL CURRENTS. II. Murmylo, G. L. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 12: 1095-1104(July 1967). (In Russian).

The excitation of high-frequency and low-frequency waves in homogeneous plasma placed in a magnetic field is discussed. Expressions are obtained for differential and integral intensities of the waves excited by axial, azimuthal, and radial modulated currents in the region of plasma transparency. High-frequency and low-frequency resonances are investigated. (auth)

44111 DERIVATION OF QUANTUM KINETIC EQUATION. Kon'kov, V. L.; Gorshenkov, V. N.; Bogdanov, E. P. (Gor'kii Research Inst. of Physics and Tech., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 71-4(1967). (In Russian).

A simplified consequential solution of the quantum kinetic equation was found for the Wigner force distribution function. (R.V.J.)

44112 WALL CONTROL OF POSITIVE COLUMNS CONSTRICTED BY NEGATIVE IONS. Woolsey, G. A.; Emeleus, K. G.; Gray, E. W.; Coulter, J. R. M. (Queen's Univ., Belfast). Int. J. Electron., 22: 235-8(Mar. 1967).

Evidence is presented to show that when a low-pressure positive column in an electronegative gas constricts, the tube wall retains considerable control if the column is diffuse, whether or not it is mobile, but that the wall loses control if the column is of filamentary, arc-like form. (auth)

44113 ELECTRICAL CURRENT IN A MOVING PLASMA BETWEEN COLD ELECTRODES. Distefano, E.; Pain, H. J. (Imperial Coll. of Science and Tech., London). Brit. J. Appl. Phys., 18: 1085-93(Aug. 1967).

The voltage between two plane electrodes immersed in a shock-heated plasma is described as a function of the current density J. An experimental study is reported with different electrode cross sections to check the theory. The current is found to vary smoothly with the voltage and J reaches higher values than in the saturation ionic current density through the sheath, so that field emission from the cathode is a conduction mechanism with a high-current régime. (auth)

44114 PRODUCTION OF A SINGLE PULSED PLASMA. Mikoshiba, S.; Fujikata, K.; Hirano, K.; Nakano, Y. (Tokyo Inst. of Tech.). Rev. Sci. Instrum., 38: 1544-5(Oct. 1967).

A plasma gun employing a short circuit for producing single pulses is described. (M.O.W.)

44115 SURFACE WAVES ALONG AN AXIALLY MAGNETIZED PLASMA COLUMN. I. SYMMETRIC MODES. Yip, G. L. (Univ. of Toronto, Ont.); Seshadri, S. R. Can. J. Phys., 45: 2889-2907(Sept. 1967).

The characteristics of surface waves excited by an axially oriented point electric dipole situated along the axis of an infinitely long and axially magnetized column of uniform cold plasma are investigated. The surface waves are found to be slow waves and exist only below the upper hybrid resonant frequency. In the gyromagnetic and plasma resonance regions, the existence of an infinite number of discrete modes is noted. The dispersion curves are presented for different values of the strength of the applied magnetic field and the column radius. Also, the power transported by the surface waves is evaluated and is found to become infinite in the two resonance frequency regions. A technique for the removal of this singularity in the surface wave power is indicated. (auth)

44116 MULTIPLE SHORT WAVE SCATTER ON A SYSTEM OF INTERACTING PARTICLES. Borovoi, A. G. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 7-11(1967). (In Russian).

The problem of multiple scatter of a plane wave on a system of a large number of scattering particles is discussed. The effects of particle interactions on the scattered radiation are described. On the basis of the kinetic transfer equation for an ideal gas, an integral equation is deduced which accurately describes the "pair collision" effects in an actual medium nonideal gas. The same equation also approximately accounts for the effects of third- and higher-order collisions. (ATD)

44117 DETERMINATION OF REACTION CROSS SECTIONS FROM MEASUREMENTS ON CYLINDRICAL CASCADE ARCS. Hermann, W.; Monterde-Garcia, A. (Technische Hochschule, Munich). Z. Phys., 205: 313-27(1967). (In German).

If once the transport coefficients $\sigma(T)$ and $\kappa(T)$ as functions of temperature are evaluated from the characteristic and temperature measurements on an arc discharge, these results can be further reduced to the various cross sections involved in the related collision processes by means of the kinetic theory. For this purpose formulas are derived for the material functions σ and κ which are still clear enough in their dependence on the different cross sections to be evaluated, and which on the other hand do not deviate too strongly from the exact solutions. As an example, for nitrogen the collision cross sections which are effective in the temperature range $5500°K \leq T \leq 15{,}500°K$ are evaluated from measurements on an arc discharge. (auth)

Production of Plasma

Refer also to abstracts 43815 and 44030.

44118 (NP-17051) ELECTRIC FIELDS AHEAD OF IONIZING SHOCK WAVES. Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). May 1967. 5p. (ER-28).

Electric potential measurements were made in hydrogen and deuterium plasmas. (M.O.W.)

44119 (SC-DC-67-1864) DETAILED MEASUREMENT OF THE X-RAY EMISSION SPECTRA OF HIGH-DENSITY KILOVOLT PLASMAS. Beckner, E. H. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 9p. (CONF-670928-3). Dep. CFSTI.

From Pulsed High-Density Plasmas Conference, Los Alamos, N. Mex.

The x-ray emission spectra of dense, hydrogenic kilovolt plasmas produced in a coaxial discharge tube have been measured in detail, utilizing a crystal diffractometer for line identification and Li-drifted germanium detectors for absolute continuum measurements. In previous work it was found that these plasmas generally contain nontrivial quantities of copper contaminant ions. Precise identification is reported of the dominant lines observed in the emission spectra of these plasmas. Since there is a significant relationship between the radiation intensity and the polarity of the center electrode of the discharge tube, both positive and negative modes of operation have been studied and x-ray intensities correlated with neutron emission rates. In both modes of operation two or more distinct x-ray pulses are generally observed: the first pulse possesses a source "temperature" in excess of 100 keV, and appears to be a simple continuum without observable lines; subsequent pulses possess strong Cu-line radiation in addition to continuum radiation corresponding to electron temperatures of 20 to 50 keV. Neutron emission is observed only at the time of the first x-ray pulse. In neither mode of operation can the x-ray emission rate and spectra be described as arising simply from plasma bremsstrahlung processes in the neutron-producing deuterium plasma. (auth)

44120 EXPERIMENTAL STUDIES OF PLASMA ELECTROCONDUCTIVITY IN A MODEL OF MAGNETOHYDRODYNAMIC GENERATOR. Maslennikov, N. M.; Germanyuk, V. N. (All-Union Electrotechnical Inst., USSR). Teplofiz. Vys. Temp., 5: 562-7(July-Aug. 1967). (In Russian).

An unbalanced electric conductivity in the induced electric field was studied, using a model of an MHD generator with 3 to 4 kn/m^2 pressure in the gas (argon with potassium) and temperature range from 1300 to 2600°K. The influence of longitudinal partitioning on the electric conductivity of the plasma was also investigated. (tr-auth)

44121 RADIAL DIFFUSION OF CHARGED PARTICLES IN A MAGNETIC FIELD AND EFFICIENCY OF A PENNING DISCHARGE ION SOURCE. Gabovich, M. D. (Inst. of Physics, Kiev). Zh. Tekh. Fiz., 37: 888-93(May 1967). (In Russian).

Approximate formulas are derived for the distribution of charged particles in a hot cathode Penning discharge ion source and the current in the ion beam extracted from it. The model ion source consists of a cylindrical anode in an axial magnetic field, the two ends of which are closed by plane reflectors (cathodes) in the center of one of which there is a circular opening for extraction of the ion beam and in the center of the other, a circular electron emitter (hot cathode) which is at the same potential as the reflector. The formulas are derived for the case of a saturated cathode, but analogous formulas can be obtained for the cases of a space charge limited cathode or a cold cathode. It is found that transverse diffusion of the charged particles can considerably reduce the current in the extracted ion beam and that the efficiency of the ion source depends significantly on its design. It is suggested that the derived formulas, after they have been confirmed by comparison with experiment, may prove useful for the rational design of hot cathode Penning discharge ion sources. (ATD)

44122 NONLINEAR PHENOMENA IN THE OPERATION OF A TITANIUM PLASMA SOURCE. Andryukhina, E. D.; Shpigel', I. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 894-902(May 1967). (In Russian).

The plasma source was operated with 2- to 8-kV pulses from a 1.5-μF capacitor with a circuit damping resistance of 0.67 ohm in an axial magnetic field of up to 4 kOe. The velocities of the plasmoids were measured with probes; the ionic composition of the plasmoid was determined with a mass spectrometer; the time characteristics of the discharge current and voltage were studied oscillographically; the energy distribution of the fast ("run away") electrons ejcted by the source was determined; and the high frequency oscillations of the plasmoid at wavelengths of 30, 8, and 2 mm were recorded. When the polarity of the voltage pulse on the plasma source was "direct," the velocity of the plasmoid increased only slowly with increasing magnetic field strength until a certain critical field strength H_c was reached, after which the velocity increased rapidly with increase of the field strength beyond H_c and again decreased somewhat when the magnetic field strength was increased far beyond H_c. The critical field strength increased with increase of the voltage applied to the source. This threshold effect did not occur when the voltage pulse to the source had the opposite ("inverse") polarity. Application of a magnetic field above the threshold value increased the energy of the hydrogen ions in the plasmoid and reduced the concentrations of heavy impurity ions. Oscillations in the 1- to 20-MHz range were observed in the discharge current; these oscillations were partially suppressed by the presence of a magnetic field. Some 20% of the "runaway" electrons had energies higher than would correspond to the potential across the source at the time when they were accelerated, and the number of these very fast electrons was greater in the presence of a magnetic field of the critical strength than in the absence of a field. The intensity and sprectrum of the microwave oscillations of the plasmoids was found to vary in a rather involved manner with the magnetic field strength; when the field strength exceeded the critical value, the oscillations were stronger than when no field was present. It is suggested that some of the phenomena might be accounted for by the presence of oscillating electric fields in the source and the coupling of these oscillations to the cyclotron oscillations in the presence of the magnetic field, but no explanation is offered for the threshold phenomena. (ATD)

44123 IONIZATION OF A MEDIUM AND PRODUCTION OF PLASMA BY A LASER BEAM. Askar'yan, G. A.; Rabinovich, M. S. (Lebedev Inst. of Physics, Moscow). Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 89-96(1966). (In Russian).

A review is presented of investigations of the use of laser beams for the solution of numerous problems in plasma physics. The first section discusses avalanche ionization of a medium by an intense light flash and is concerned with field strengths of

10^7 V/cm or over. The second section discusses the diamagnetic perturbation due to ionization of the medium in a beam of intense light, specifically, the possible effects on such plasma by external inhomogeneous magnetic fields. The hot plasma's diamagnetism makes it possible for an inhomogeneous magnetic field to act upon it by accelerating the ionized clouds or throwing it into a trap. A very high field strength (10^5 to 10^6 Oe) applied to small plasma clouds can produce extremely high ejection speeds which can be employed for various plasma and pre-thermonuclear processes. The third and fourth sections concern magnetic traps. The advantages of action of intense light upon dense matter placed directly in a magnetic trap are discussed. The steep characteristic of the dependence of ionization rate of rarefied gas on the intensity of light makes it possible, by increased intensity of the light beam (of about 500 Mw), to ionize fast particles (e.g., 10^8 cm/sec) with a probability close to unity. The most advantageous method would be action upon molecular ion beams directed into the trap. The analysis of the processes involved also shows the advantages of using higher harmonics, polarized atoms, and light beams modulated by half the natural frequency of the atoms in the molecule, and by various resonance manipulations of the pumping field. (ATD)

44124 PRODUCTION OF A CESIUM PLASMA BY RESONANCE IRRADIATION AND SOME OF ITS PHYSICAL PROPERTIES. Morgulis, N. D.; Korchevoi, Yu. P.; Przhonskii, A. M. (Kiev State Univ.). Zh. Eksp. Teor. Fiz., 53: 417-22(Aug. 1967). (In Russian).

Cesium vapor in a special detector with a double probe was irradiated by resonance irradiation from a discharge in cesium vapor. Under these conditions a "quiet" currentless cesium plasma was created. The probe was used for measuring the parameters of the plasma, such as the electron concentration and temperature, which in typical cases were, respectively, 5×10^{11} cm^{-3} and $\gtrsim 2000°K$. The possible nature of the processes occurring in such a plasma and especially ionization processes and electron thermalization, as well as the character of the regularities observed, are considered. In particular, the chief ionization mechanism in this case can probably be described by the two-step scheme: (1) $Cs + h\nu \rightarrow Cs^*$, and (2) $Cs^* + Cs^* \rightarrow Cs_2^+ \rightarrow Cs_2^+ + e$, i.e., the plasma should mainly consist of molecular ions. (auth)

44125 FULLY-IONIZED BARIUM PLASMA SOURCE. Rynn, N.; Hinnov, E.; Johnson, L. C. (Princeton Univ., N. J.). Rev. Sci. Instrum., 38: 1378-84(Oct. 1967). (MATT-474).

A device for generating a fully ionized barium plasma column is described. It is similar to the previously described Q1 device except for the substitution of rhenium ionizing surfaces for tungsten, and barium for the alkali metals. The main motivation for the use of barium is that singly ionized barium has its resonance lines in the visible wavelength range, and thus allows the use of spectroscopic techniques for the determination of various plasma parameters. The special problems of barium in a Q device, and the spectroscopic techniques, including range of applicability and achievable accuracy of the measurements, are discussed. (auth)

Stability of Plasma

Refer also to abstract 44022.

44126 (COO-1695-4) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Quarterly Progress Report No. 2, June 15, 1967-September 14, 1967. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). Sept. 15, 1967. Contract AT(11-1)-1695. 17p. Dep. CFSTI.

Research is being conducted to investigate the ability of a short pulse of electron cyclotron resonance radiation to produce an anisotropic energy distribution of electrons in a plasma, and the instabilities and waves produced by this anisotropy. The electron cyclotron resonance device was operated in further attempts to obtain additional free-free x-ray bremsstrahlung measurements. A two-pulse code network was constructed to permit the magnetron to be pulsed again immediately upon the conclusion of a heating pulse. A brush cathode gun was constructed and placed in the vacuum chamber. A theoretical treatment for the anisotropic production of bremsstrahlung is given. (M.O.W.)

44127 (NP-16948) NONEQUILIBRIUM PROPERTIES OF MAGNETOPLASMAS. Semiannual Status Report No. 1, September 1, 1966-February 28, 1967. Holt, E. H.; Noon, J. H.; Gunshor, R. L. (Rensselaer Polytechnic Inst., Troy, N. Y. Plasma Dynamics Lab.). July 1967. 19p. CFSTI.

Studies are in progress on instabilities in an arc plasma; on the current convective instability of collision dominated plasmas; and on the occurrence of non-Maxwellian electron velocity distributions in plasmas. The arc plasma facility has been constructed and put into operation. With argon gas fed continuously through a hollow cathode and the resultant ionized gas collimated by a magnetic field in the region between the anode and cathode, the arc has been operated up to a current of 80 amps and Langmuir probe measurements of the electron temperature and density have been made. The characteristics of the current convective instability in the hollow plasma column typical of some plasma accelerators have been investigated. Langmuir probe measurements of the radial form of the perturbed electron density reveal that the rotating helix is concentrated in the outer region of the plasma. The instability occurs at a lower value of the critical magnetic field for a hollow plasma than for a regular positive column of the same diameter. For both the regular and the hollow positive column the use of measured plasma density profiles in the numerical evaluation of the stability criterion is shown to give improved agreement between theory and experiment. The theory of the current convective instability has been generalized to include the case of an applied magnetic field with shear. The new theory predicts that when the total helical magnetic field and the helical density perturbation have the same sense, the plasma is destabilized and a mode switch should occur at a certain value of the azimuthal component of the magnetic field. In the opposite case the plasma is predicted to be stabilized and the m = 1 mode is predicted to be dominant. An experiment has been performed and these predictions have been confirmed. A comprehensive study of the occurrence of non-Maxwellian electron velocity distributions in an active nitrogen plasma has been made. It is shown that such distributions occur below a critical current level in the discharge and within a certain critical time after the initiation of the discharge. (auth)

44128 (ORNL-4150, pp 36-46) INJECTION AND ACCUMULATION: NEUTRAL INJECTION EXPERIMENTS (DCX-1.5). (Oak Ridge National Lab., Tenn.).

Investigations of the properties of plasma established by Lorentz trapping of 15-keV H^0 in a magnetic mirror trap (B_0 to 14 kG) have continued. Two microinstabilities are observed. One, which we term the Z mode, is associated with axial current fluctuations. The other, the θ mode, is associated with azimuthal current fluctuations. In addition there are unstable and stable flute oscillations. The Z and the stable flute modes have low density thresholds and do not drive proton losses. They are generally terminated at higher densities (in the 10^7 cm^{-3} range) by transition to the θ or to the unstable flute mode. Transition to either of these modes establishes an instability limit on plasma accumulation. It is found that the θ instability can be suppressed by operation at high magnetic field ($B_0 \gtrsim 12.5$ kG), and that the unstable flute can be suppressed by operation with grounded end walls close to the hot plasma. The control for the unstable flute is that suggested by the concepts of line-tying stabilization, and the observations are compared with a recent theory of such stabilization. With both θ and unstable flute modes suppressed, the Z and stable flute modes remain, and plasma confinement is limited by charge-exchange losses up to trapped fast-proton densities of at least 1×10^8 cm^{-3}, the highest obtained during this report period. Continuing work toward beam improvement has included testing a barium neutralizing cell for production of the H^0 beam and also passing the incoming H^0 beam through a magnesium arc operated in the fringing magnetic field. Both experiments were attempts to enhance the excited-state populations over those routinely available with our usual magnesium neutralizer, but neither was successful. A technique which has produced as much as 55% energy spread (full width at half maximum) of the trapped protons is also described. (auth)

44129 (ORNL-4150, pp 47-55) INJECTION AND ACCUMULATION: MULTIPLE-PASS EXPERIMENTS (DCX-2). (Oak Ridge National Lab., Tenn.).

Preparations have been made to measure the velocity distribution function at the times of instability onset during the plasma decay following beam turnoff in order to obtain a quantitative comparison with theory. The scaling law for energetic plasma density vs input beam current is being investigated in an effort to extend this central peak stability study to higher densities. An instability of the Harris type has been observed in the DCX-2 ion beam. The instability results from a coupling of the ion cyclotron motion to electron plasma oscillations along the field. It does not lead to a gross perturbation of the ion beam trajectory since saturation occurs at a low level of the rf electric fields. The waves resulting from the instability propagate in the direction of ion rotation and in both directions along the magnetic field. The wave propagating parallel to the ion beam axial velocity appears to be convectively unstable, whereas the antiparallel wave is absolutely unstable. (auth)

44130 DYNAMIC STABILIZATION OF THE THETA PINCH. Haas, F. A.; Wesson, J. A. (United Kingdom Atomic Energy

Authority, Abingdon, Eng.). Phys. Rev. Lett., 19: 833-5(Oct. 9, 1967).

Previous work has shown the periodic $\beta = 1$ theta pinch to be marginally stable to the mode $m = 1$ and unstable for all $m > 1$. It is shown that such a pinch can be dynamically stabilized for all $m \geq 1$. (auth)

44131 FINITE-RESISTIVITY STABILITIES OF A SHEET PINCH. Wei, Chau-chin (Nagoya Univ., Japan). J. Phys. Soc. Jap., 23: 873-81(Oct. 1967).

A simple but general approach to obtain the stability criteria is presented through an elementary proof of the uniqueness theorem for the higher order parabolic equations by constructing an energy inequality. The theorem is applied to the isothermal, resistive, viscous, and incompressible MHD equations of a sheet pinch where the equations are reduced into an equation governing the two-dimensional vorticity and an equation governing the parallel motion with respect to the acting force. The theorem yields the conditions for the stable parallel motion and for the conservation of vorticity. The result is compared with other works and the effects of viscosity and resistivity are discussed. (auth)

44132 APPLICATION OF DISTRIBUTED AUTOMATIC CONTROL SYSTEMS TO THE STABILIZATION OF PLASMAS. Paslavskii, E. S.; Samoilenko, Yu. I. (Inst. of Cybernetics, Kiev). Zh. Tekh. Fiz., 37: 983-5(May 1967). (In Russian).

A brief discussion is given of the use of distributed automatic control systems to control distributed objects. Also a brief discussion is given of the control of kink instability of a plasma filament by equal currents of opposite phase in the plasma filament and the conducting wall of the chamber containing it. An expression is written for the restoring force, and the stability conditions are given for both cylindrical and toroidal geometry. The undesirable pulsation of he restoring force at twice the frequency of the stabilizing current can be avoided by applying a second similar system of currents shifted both spatially and temporally with respect to the first by 90°. If the amplitudes are properly chosen there arises a field of circular polarization which assures constancy of the magnetic pressure. Moreover, sausage instabilities will be stabilized by the circularly polarized field. (ATD)

44133 ION-CYCLOTRON INSTABILITY OF A PLASMA IN A STRONG HIGH-FREQUENCY FIELD. Silin, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 37: 991-3(May 1967). (In Russian).

Instabilities in a plasma in a uniform constant magnetic field and a sinusoidal electric field of uniform amplitude are discussed briefly with the aid of a dispersion equation quoted from earlier work of the author and collaborators. For perturbations with transverse wavelengths long compared with the ion Larmor radius and frequencies close, but not too close to a harmonic of the ion Larmor frequency, the ion Cherenkov effect is always positive and tends to damp out the ion cyclotron oscillations, but the electron effect can be of either sign. The stability condition as written, is discussed briefly for simplifying asymptotic conditions, and is presented graphically for the case when the electron Larmor radius is small compared with the wavelength, which in turn is small compared with the electron Debye radius. (ATD)

44134 DRIFT INSTABILITY OF THE PLASMA IN AN OSCILLATING ELECTRON (PIG) DISCHARGE. Dushin, L. A.; Kuznetsov, Yu. K.; Pavlichenko, O. S. Zh. Tekh. Fiz., 37: 811-16(May 1967). (In Russian).

The oscillations of the plasma in up to 2-kV, 1-A PIG discharge in H_2 and He at pressures from 10^{-5} to 10^{-1} mm Hg between 3.5-cm-diameter water cooled aluminum cathodes 60 cm apart in a 10-cm-diameter 1-m-long copper chamber were investigated. The magnetic field strength could be varied up to 3 kOe. The spectra of the fluctuations of the discharge current, the saturation ion current to a double Langmuir probe, and the strengths of 8.8-, 14.2-, and 37.4-kMHz microwaves transmitted by the plasma were recorded over the frequency range from 50 to 30 MHz. The charged particle densities in the plasmas (typically 10^{12} cm^{-3}) were measured with a 37.4-kMHz microwave interferometer, the electron temperatures (20 to 70 eV) were determined from the intensity ratios of appropriate lines in the helium spectrum, the ion temperatures (0.1 eV) were determined from the Doppler broadening of spectral lines, and the charged particle current transverse to the magnetic field was measured with a double Langmuir probe. The work was undertaken to investigate the behavior in a metallic discharge chamber of the strong low-frequency oscillations previously observed in PIG discharges in glass chambers by two of the authors and collaborators (Zh. Tekh. Fiz., 34: 590(1964)). The oscillations observed in the present work were similar to but stronger than those previously observed in glass discharge chambers. At low discharge currents and in weak magnetic fields the oscillations were confined to a few narrow widely spaced frequency bands (typically at 8.3, 15.5, 22.2, and 30 MHz). These oscillations are ascribed to successive modes of the longitudinal oscillations of the electrons in the plasma column. When the discharge current and/or the magnetic field strength was increased, the high frequency (above 15 MHz) oscillations rather suddenly disappeared and strong low frequency oscillations appeared in the 3 to 5 MHz region. These low frequency oscillations exhibited a harmonic structure with a spacing of 300 to 700 kHz between successive harmonics. Similar "harmonics" appeared also in the vicinity of peaks at 6.8 and 8.8 MHz. Simultaneously with the change in the character of the oscillations there began an increase in the rate of escape of charged particles from the plasma column. The observed phenomena are discussed in terms of the theory of drift-dissipative instabilities elaborated by A. V. Timofeev (1963). It is concluded that drift-dissipative instability of the plasma is responsible for the observed oscillations, and that it may also be responsible for the concomitant anomalous diffusion. (ATD)

44135 LOW-FREQUENCY PLASMA INSTABILITIES. Kogan, E. Ya.; Moiseev, S. S. (Novosibirsk State Univ., USSR). Zh. Tekh. Fiz., 37: 805-10(May 1967). (In Russian).

The stability of a plasma in a magnetic field is discussed with respect to perturbations with propagation velocities in the direction of the field that are lower than the thermal velocity of the ions. The dispersion equation for such perturbations is derived from the linearized kinetic equation with no collision terms, and stability conditions are obtained. It is shown that if the temperature and density gradients in the plasma are not collinear, the instability region is considerably wider than that found by Galeev, Oraevski, and Sagdeev (1963). It is shown also that low-frequency instabilities of the discussed type can develop in an isothermal plasma when the ion Larmor radius is much greater than the wavelength of the perturbation in the direction perpendicular to the magnetic field. In the high temperature limit the transverse diffusion constant is considerably greater than the classical transverse diffusion constant. Landau electron damping leads to the possible appearance of universal instabilities of the discussed low-frequency type. These instabilities cannot be easily stabilized by magnetic shear, very large shears being required. (ATD)

44136 ION-CYCLOTRON INSTABILITY OF A PLASMA IN AN ADIABATIC TRAP WITH A MINIMUM B. Baiborodov, Yu. T.; Ioffe, M. S.; Sobolev, Yushmanov, E. E. Zh. Eksp. Teor. Fiz., 53: 513-27(Aug. 1967). (In Russian).

The appearance of cyclotron instability at a plasma density $\sim 5 \times 10^9$ cm^{-3}, ion energy ~1 keV and magnetic field strength of 3000 oersted is investigated. The instability is manifest as a number of 30- to 40-μsec flashes accompanied by uhf oscillations and by ejection of the plasma onto the walls. The flashes may differ with respect to their nature. The magnitude of the plasma ejected onto the wall corresponds to the observed decrease of the density. The distribution of the plasma flux towards the wall indicates that the losses parallel and perpendicular to the magnetic field are of the same order of magnitude. The strong longitudinal expansion of the plasma during an instability flash also indicates a turn of the velocity vectors in the direction of the forbidden cone. The uhf signal possesses a linear structure with the first harmonic corresponding to the ion-cyclotron frequency prevailing. The magnitude of the electric field amplitude gives reason to assume that long wave oscillations with $\lambda \approx 30$ cm are built up in the plasma, the oscillations being characterized by an appreciable violation of quasineutrality of the plasma (by several percent) and by potential oscillation amplitudes of the order of a kilovolt. Quantitative comparison of the available experimental data with the theory of cyclotron instability of an homogeneous plasma does not yield consistent results. (auth)

44137 THEORY OF HYDROMAGNETIC STABILITY OF TOROIDAL PLASMA CONFIGURATIONS. Solov'ev, L. S. Zh. Eksp. Teor. Fiz., 53: 626-43(Aug. 1967). (In Russian).

Criteria of local and convective stability of equilibrium plasma configurations of arbitrary geometry are considered. The stability of axially symmetric plasma configurations exemplified by a toroid with a longitudinal current is investigated on basis of these criteria. The usual restrictions to cases of small toroidality and small plasma pressure are neglected. The effect of the shape of the torus cross section on the stability is considered. (auth)

44138 TWO-STEAM INSTABILITY IN PLASMA. Uberoi, C. (University Coll., Cardiff, Wales); Bhatnagar, P. L. J. Appl. Phys., 38: 3801-7(Sept. 1967).

The problem of two-stream instability in plasma is studied by specifying the importance of initial magnetic field associated with the motion of the charged particles and the boundary effects. In Part I the accurate initial steady state is studied when the streams

of electrons and ions move with different uniform speeds in plasmas and cylindrical geometry. In Part II, in order to show the effects of finiteness and inhomogeneity of the system, small transverse plasma oscillations are studied in the case of plane plasmas. The role of plasma-sheath oscillations at the boundaries is found to be very important in driving the instabilities associated with the electromagnetic modes. The numerical estimates of the growth rates of the instability are given for the specific case of the physical data in discharge tubes. (auth)

44139 RADIAL DENSITY PROFILE AND CRITICAL MAGNETIC FIELD MEASUREMENT FOR THE HELICAL INSTABILITY IN A HOLLOW PLASMA COLUMN. Reynolds, J. F.; Holt, E. H.; Jennings, W. C.; Noon, J. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). Appl. Phys. Lett., 11: 148-50(Sept. 1, 1967).

The characteristics of the current convective instability in a hollow plasma column are described. Langmuir probe measurements of the radial form of the perturbed electron density reveal that the rotating helix is concentrated towards the outer wall of the discharge vessel. The instability has been shown to occur at a lower critical magnetic field for a hollow plasma cell than for a regular positive column cell of the same dimensions. Neither of these features are considered in previous theoretical work. For both the regular and the hollow positive column, the use of measured electron density profiles in numerically evaluating a stability criterion is shown to give improved agreement between theory and experiment. (auth)

Thermonuclear Processes

Refer also to abstracts 44020 and 44022.

44140 (NP-17045) THERMONUCLEAR REACTIONS IN SUPERNOVA SHOCK WAVES. Truran, James Wellington (Yale Univ., New Haven, Conn.). 1966. 155p.

Thesis.

The influence of a supernova shock wave on the abundances of the nuclear species present in the stellar medium is considered. The temperature of the medium immediately behind the shock may typically be $\sim 5 \times 10^{9}$°K. Nuclear reactions proceeding on the products of earlier nuclear burning phases can result in the formation of heavier nuclei. In order to follow these nuclear transformations, a nuclear reaction network is established providing suitable reaction links connecting neighboring nuclei. Thermonuclear reaction rates are determined for all neutron, proton, and alpha-particle reactions involving the nuclei in this network from a consideration of the statistical properties of nuclei. The calculated rates are compared with experiment both for charged particle reactions on lighter nuclei and for neutron capture reactions proceeding on nuclei in the mass range $A > 60$. Good agreement is obtained in both cases. Employing these calculated values of the rates in the nuclear reaction network, the effect of a peak shock temperature of 5×10^{9}°K on regions of ^{12}C, ^{16}O, ^{28}Si, and ^{32}S is studied. It is shown that the nuclei in the silicon-to-calcium mass region can be formed by this mechanism. The observed solar and meteoritic abundances display a broad peak in the vicinity of iron, the most abundant nucleus in this region being ^{56}Fe. In these calculations, ^{54}Fe is determined to be the most abundant isotope in this mass range. It is suggested that at somewhat higher densities, $\rho \sim 10^{8}$ to 10^{9} gm·cm^{-3}, electron capture on ^{32}S may produce large quantities of ^{32}Si before the passage of the shock. The increased ratio of neutrons to protons in the system may lead to the production of large amounts of ^{56}Fe, rather than ^{54}Fe. (auth)

44141 (ORNL-4150, pp 71-102) PLASMA PHYSICS. (Oak Ridge National Lab., Tenn.).

An unusual deuterium plasma is generated by a reflex electron beam on the axis of a simple magnetic mirror trap we call Burnout V. The plasma is extremely turbulent (rf radiation), appears to be highly ionized (neutral spectra reduced by 10^{3}), and emits D-D reaction products (10^{3} protons sec^{-1} cm^{-3}). The technique is described for determining the plasma origin of the D-D reaction protons, using nuclear emulsions and a CsI crystal-light-pipe-photomultiplier combination. A 10% background of wall reactions verifies the presence of energetic deuterons. The presence of impurities has been found to drastically reduce the reaction rate. Containment time was not actually measured, but is thought to be several hundreds of cyclotron periods. Landau damping of ion-acoustic waves was investigated as a function of wave frequency. Damping in this experiment is accomplished by introducing a light contaminant ion species into a heavy-ion-species plasma. By choosing a contaminant ion whose thermal velocity is the same as the velocity of the wave, strong Landau damping can be effected with only a few percent contamination by the added ion species. Both quantitative and qualitative agreement has been found between experimental observations and the predictions of a linear theory for a two-ion-species plasma. This technique for studying Landau damping seems superior to previous techniques involving significant variations of the bulk properties of the plasma. The high-pressure arc experiments are concerned with the properties of a fully ionized plasma surrounded by neutral gas. Power balance and plasma temperature, density, and stability are studied. An ohmically heated plasma cylinder is produced in the magnetically collimated helium arc between an incandescent tungsten cathode and a water-cooled copper anode. Spectroscopic observations indicate electron density up to $\sim 4 \times 10^{16}$/cm^{3} at 100-torr gas pressure and nearly full double ionization of the helium in the core at pressures less than 100 torr. Present results indicate no difficulty in maintaining a hot plasma surrounded by neutral gas at some tens of torrs gas pressure. They provide no information regarding the possibility of using higher gas pressure. Axial electron densities up to 3.7×10^{16} e/cm^{3} at 100 torr of helium have been obtained for the pulsed 5000-A magnetically constrained helium arc. The small-scale program in toroidal multipole plasma confinement studies is now under way. The initial experiment, using a small quadrupole, investigated the feasibility of using 60-Hz electromagnetic levitation as a solution to the hoop-support-loss problem present in existing toroidal multipole devices. A larger model (35-cm diam) was built for plasma studies having a sculpted internal cross section to minimize inductance and hoop coupling, thereby maximizing field strength. In this improved geometry the solid copper hoops could be levitated with only a small-amplitude oscillation for the total duration of each pulsed plasma experiment ($\sim$½ sec). A maximum field of >3 kG near the hoops has been attained with only one-half the possible maximum flux (i.e., iron) threading the quadrupole. A crowbar designed to extend the duration of the magnetic field to at least 5 msec has been constructed; the earlier crowbar on the small quadrupole resulted in a field with an 8-msec decay time. Injection of plasma from a titanium washer gun into the levitated quadrupole has begun, and first interpretations of the double probe signals indicate plasma activity for at least the first transit around the machine. Field calculations and levitation experiments concerning a twisted octopole are being carried out. In addition, microwave equipment is being assembled for ECRH experiments in both the quadrupole and octopole magnetic field configurations. The Penning ion gage, because of its electrical similarity to DCX, has been used to study electron transport across a magnetic field. Methods of transport control by means of tuned walls have been developed. The fluctuations in potential and ion saturation current to Langmuir probes in the halo of the hydrogen arc have shown correlations at frequencies of approximately 250, 50, and 2 kc. The phase velocity of the fluctuations at 250 kc corresponds approximately to the diamagnetic drift velocity associated with the arc core. The sense of propagation is in the direction of electron drift. The radial correlation distance determined from the decay of the rms saturation-current amplitude with radius was found to be considerably shorter than the radial distance determined from the product of the measured radial velocity and the decay time of the ions from the plasma as seen on the detector at one end of the field. This implies that the density fluctuations do not remain coherent throughout the lifetime of the ions in the plasma. (auth)

Shielding

Refer also to abstracts 43099 and 44471.

44142 (ORNL-RSIC-15(Rev.1)) BIBLIOGRAPHY OF THE COMPUTER CODES LITERATURE EXAMINED BY THE RADIATION SHIELDING INFORMATION CENTER, JULY 1967. Maskewitz, Betty F. (comp.); Jacobs, Vivian A.; Gurney, Jane (eds.) (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 68p. Dep. CFSTI.

This bibliography covers literature which describes not only shielding computer codes, but nuclear codes in a fringe area of shielding, and some miscellaneous information which might be of general interest. (M.O.W.)

44143 AN INVESTIGATION OF DIFFERENTIAL ENERGY AND ANGLE SPECTRA FOR ^{137}Cs GAMMA RAYS IN WATER AND AIR. Alberg, Mary; Beck, Harold; O'Brien, Keran; McLaughlin, James E. (Atomic Energy Commission, New York). Nucl. Sci. Eng., 30: 65-74(Oct. 1967).

Differential energy and angle spectra from a point isotropic ^{137}Cs source in an effectively infinite medium of water were determined for γ-ray penetrations of 1, 2, 3, and 4 mean free paths at 15° intervals. The spectra were unfolded from scintillation spectrometer measurements by an analytic method based on the Scofield iteration scheme. An integration of the results over all angles yielded differential energy spectra which were consistent with multigroup transport calculations. The measurements were also

carried out in a condensed, air-like medium. A comparison of the results with those obtained in water showed that the differences in attenuation coefficients between the two materials caused spectral differences only at very low energies for small separations between source and detector, which were consistent with theoretical calculations. (auth)

44144 A PHOTON TRANSPORT CODE IN SPHERICALLY SYMMETRIC GEOMETRY, 06 NIOBE–G. Kataoka, Iwao; Takeuchi, Kiyoshi (Ship Research Inst., Tokyo). Senpaku Gijutsu Kenkyujo, 2: 297-309(Nov. 1965). (In Japanese).

A series of codes, 06 NIOBE-G, was written for the NEAC 2206 computer for the numerical integration of the time-independent photon transport equations in spherically symmetric geometries. The original NIOBE was prepared for the IBM 704 and later for the IBM 7090. At present there are two versions of the 06 NIOBE, the 06 NIOBE-G1 and the 06 NIOBE-G2. The G1 code is almost identical with the original NIOBE in general view of its mathematical treatments. The G2 was introduced with a view to decreasing some of errors in solutions ascribed to the procedure of spatial integrations in the NIOBE which were found as one of the results of test calculations of the G1 code. In the procedure of spatial integration of the transport equations, the G2 code applies the Lagrange interpolation formula not only to estimating angular distributions but also to radial interpolation. This has brought on two main improvements. First, it gives fairly close approximations to exact solutions of test calculations in the cases where the G1 code shows remarkable deviations. Second, it shows a decrease of 30% of a computation time for one iteration against one of the G1 code. Except for the differences between the two versions of the code, for the most part the results of test calculations with these codes agree well with exact solutions within approvable error. The concept of the NIOBE approximating angular distribution of fluxes with finite terms of the Legendre polynomials, however, occasionally leads to difficulties in treating problems in which the flux varies steeply in magnitude with directional angle. (NSA of Japan)

44145 ON THE TRANSITION EFFECT THEORY FOR γ RADIATION. Galishev, V. S. (Ural State Univ., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 147-9(1967). (In Russian).

Transition effects of γ radiation penetrating through a two-layer absorber were resolved by means of an approximate method similar to the Belen'kii method (Shower Processes in Cosmic Rays, Gostekhizdat, 1948). (R.V.J.)

44146 NUCLEON–MESON CASCADE AND SHIELDING. Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Science, 157: 1399-1405(Sept. 22, 1967).

Various considerations necessary for designing of radiation shields for manned space vehicles and for high-energy accelerators are discussed: interactions of neutrons, protons, pions, and muons in matter; the development of a nucleon-meson cascade; and a method by which the radiation hazard behind a shield can be determined. It is pointed out that, in the case of present manned space vehicles and those contemplated in the near future, the secondary particles from nuclear reactions contribute only a fraction of the total radiation hazard, and relatively accurate design calculations for radiation shields can be made. In the case of high-energy accelerators, the secondary particles from nuclear reactions contribute the entire radiation hazard, and only very approximate design calculations for shields are at present possible. (L.B.S.)

Solid-State Physics

Refer also to abstracts 43657, 43664, 43673, 43945, 43966, 44519, 44520, 44537, 44540, 44771, and 44809.

44147 (AECL–2757) THE PENETRATION OF keV PROJECTILES IN SOLIDS. Davies, J. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1967. 13p. (CONF-670534–5). Dep. CFSTI. CAN $0.50.

From 15th Annual Conference on Mass Spectrometry and Allied Topics, Denver, Colo.

During the past five years, a large amount of experimental information on the penetration of energetic (0.5 to 500 keV) ions in solids has been obtained. The technique consists in bombarding the solid with a monoenergetic beam of radioactive ions, and then subsequently measuring the depth distribution of the embedded radioactivity by a high precision (~ ±10 Å) sectioning technique. Results are summarized and compared with Lindhard's theoretical predictions. In amorphous targets, the agreement between experiment and theory is quite good, i.e., within ±20%. In oriented crystalline targets, however, the mean penetration is increased by up to a factor of 10 by channeling of the beam along the open directions or planes in the lattice. The dependence of this channeling effect on the energy and atomic number of the projectile has been investigated thoroughly; also its dependence on radiation damage, surface imperfection, and misalignment of the crystal has been studied. (auth)

44148 (COO–7-0422) INTERNAL MAGNETIC FIELDS AT Mo, Ru, Pd, Sm, AND Pt NUCLEI IMPLANTED IN Fe, Co, Ni, AND Gd METALS. Murnick, D.; Grodzins, L.; Kalish, R. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science); Borchers, R. R.; Bronson, J.; Herskind, B. (Wisconsin Univ., Madison). Aug. 23, 1967. Contract AT(11-1)-Gen-7. 11p. (CONF-670812–12). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

The internal magnetic fields at nuclei of isotopes of Mo, Ru, Pd, Sm, and Pt implanted into ferromagnetic hosts have been studied using the ion implantation perturbed angular correlation technique, IMPACT. The magnitudes of the internal fields are found to be approximately proportional to the magnetic moments of the host atoms in Fe, Co, and Ni indicating that any anomalous fields are proportional to the host moment. The ratios of the fields reported also agree quite well with those measured using other techniques. The sign of the field is positive in Ru, Pd, and Pt and negative for Sm. The fields acting on the nuclei implanted in Gd (at 80°K) are positive and equal to about 350 kG for Mo, Ru, and Pd. The field on Sm in Gd is −300 kG and on Pt in Gd = 160 kG. (auth)

44149 (COO–7-0423) ANOMALOUS HYPERFINE FIELDS IN Fe HOSTS. Herskind, B.; Borchers, R. R.; Bronson, J. D. (Wisconsin Univ., Madison); Murnick, D. E.; Grodzins, L.; Kalish, R. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Aug. 23, 1967. Contract AT(11-1)-Gen-7. 30p. (CONF-670812–9). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

IMPACT measurements on the first 2^+ states of the even isotopes, ^{98,100}Mo, $^{98-104}$Ru, $^{104-110}$Pd, $^{110-116}$Cd, and $^{120-128}$Te, have indicated the presence of an anomalous hyperfine magnetic field. The effect is most pronounced for short-lived excited states, indicating that the anomalous field is time dependent and short-lived. Most of the present measurements are consistent with a field of several mOe having a lifetime of a few psec. The most likely mechanism for the field appears to be the pickup of polarized electrons during the slowing down process in Fe. (auth)

44150 (COO–1434-3) INTERSTITIAL DIFFUSION IN NON-METALLIC CRYSTALS. Technical Progress Report No. 3. Johnson, Owen W. (Utah Univ., Salt Lake City. Dept. of Physics). Aug. 31, 1967. Contract AT(11-1)-1434. 8p. Dep. CFSTI.

RUTILES— diffusion of interstitials in; coloration by mercury; spectra of protons and defects in, absorption, (E); electric conductivity of oxidized crystals of, (E)

PROTONS— complexes with cations and defects in rutile, absorption spectra, (E)

ALUMINUM IONS— IRON IONS— complexes with protons in rutile, absorption spectra, (E) (D.L.C.)

44151 (INR–796/II/PS) NEUTRON DIFFRACTION STUDY OF ANTIFERROMAGNETISM IN USb_2 AND UBi_2. Leciejewicz, J.; Troc, R.; Murasik, A.; Zygmunt, A. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 22p. Dep.

Magnetic ordering in polycrystalline USb_2 and UBi_2 has been determined by neutron diffraction. The magnetic unit cell in USb_2 is twice the chemical one along the c axis. Ferromagnetic layers are stacked along the c axis with the sequence + − − +. In UBi_2 the magnetic and chemical unit cells coincide. The ferromagnetic layers are also stacked in the direction of the c axis with a sequence + − + −. In both substances the magnetic moments of U are parallel to the fourfold axis. Their magnitudes are: $0.94 \pm 0.03\ \mu_B$ in USb_2, and $2.1 \pm 0.1\ \mu_B$ in UBi_2. (auth)

44152 (IS–T–173) TRANSPORT PROPERTIES OF THULIUM SINGLE CRYSTALS. Edwards, Leon Roger (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 85p. Dep. CFSTI.

Thesis.

Single crystals of thulium have been grown by the strain anneal technique. The electrical resistivity, thermal conductivity, and Seebeck coefficients were measured along the basal plane and c-axis crystallographic directions as a function of temperature from 5 to 300°K. All measurements indicated a magnetic transition in the temperature range 55 to 58°K. This is in agreement with a Néel temperature of 56°K as determined by neutron-diffraction measurements. The Seebeck coefficient and the thermal conductivity of the c-axis crystal exhibited a second anomaly

at 30°K, which is in agreement with the anomaly found in low-field ac susceptibility measurements and is in disagreement with the neutron-diffraction results. The anomalies observed in the electrical resistivity and thermal conductivity at the Néel temperature were interpreted in terms of magnetic superzones. All measurements exhibited a significant anisotropy between the basal plane and c-axis directions. The high-temperature anisotropy of the electropy of the electrical resistivity and thermal conductivity was interpreted in terms of the anisotropy of the Fermi surface. (auth)

44153 (IS-T-179) A STUDY OF THE F' CENTER IN SEVERAL ALKALI HALIDES. Robinson, David Atherton (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 98p. Dep. CFSTI.

Thesis.

The F' band was produced and measured in the following alkali halides: NaCl, KCl, KBr, KI, RbCl, RbI, CsBr, and CsI. The spectra consisted of a single main peak and either a shoulder or a distinct second peak to the high-energy side of it. The main peak in NaCl had a symmetrical bell shape, whereas in the remainder of the salts it showed some structure. The potassium and rubidium salts showed a shoulder located on the high-energy side of the main peak. The cesium halides showed a more complex structure. The structure in the main peak may be attributed to differences in band structure between the sodium halides and the other alkali halides. The shoulder, or second peak, to the high-energy side of the main peak was assigned tentatively to F' center absorption where the F center is left in an excited 2p state. A semicontinuum model variational calculation was also carried out using a correlated Hylleraas wave function. The F' binding energies were calculated in a self-consistent a priori fashion for $m^* = m_e$ and $0.6m_e$. (m^* is the conduction band effective mass.) Generally good agreement with experimental binding energies was achieved for the $m^* = 0.6m_e$ case. Also the potential well was adjusted to force agreement with experimental binding energies for the $m^* = m_e$ case. The resulting wave functions were used to calculate the absorption coefficients for the F' centers. Generally good agreement was obtained concerning the positions and sizes of the main peaks and their half-widths. The second absorption edges, corresponding to leaving the F center in an excited 2p state, were calculated. Good agreement with the experimental second edges was obtained. A preliminary calculation, concerning the peak height and half-width of this second band, yielded results in fair agreement with data on KBr. (auth)

44154 (UCRL-17509) RESONANCE DESTRUCTION OF ANGULAR CORRELATIONS: ^{100}Rh IN Fe AND Ni. Matthias, E.; Shirley, D. A.; Edelstein, N.; Koerner, H. J.; Olsen, B. A. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 31p. (CONF-670812-11). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

NMR absorption in the 235-nsec state of ^{100}Rh has been detected by angular correlations, employing the hyperfine fields of Rh in Fe and Ni. Dependence of the resonance effect on rf power and polarization of the host foil has been studied. The observed line width as well as the power dependence can be qualitatively understood by comparison with theoretical expectations. Evidence for localized moments is found from the temperature variation of the resonance frequency. A possible $^{100\,m}$Rh–^{103}Rh hyperfine anomaly is discussed. (auth)

44155 (UCRL-17701) ANGULAR CORRELATION STUDIES OF CADMIUM AND RUTHENIUM IN NICKEL. Shirley, D. A.; Rosenblum, S. S.; Matthias, E. (California Univ., Berkeley. Lawrence Radiation Lab.). July 1967. Contract W-7405-eng-48. 12p. (CONF-670812-13). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

Experimental studies of the hyperfine fields at nuclei of ^{99}Ru and ^{111}Cd in a nickel lattice are described. Measurements were made from 4°K to above the Curie temperature, using the method of time-dependent perturbed angular correlation. (M.H.R.)

44156 (UUIP-500) DARK FIELD IMAGES AT 1 MILLION VOLT ELECTRON MICROSCOPY. Vingsbo, Olof (Uppsala Univ. (Sweden). Inst. of Physics). Oct. 1966. 21p. Dep.

Dark field contrasts of dislocations, stacking faults, and equal thickness fringes were studied. For a constant specimen orientation the dark field images produced by the Bragg reflection and several non-Bragg systematic reflections were compared. It was found that the systematic reflections can be divided into two categories according to their position in the reciprocal lattice. One category gave dark field images with a contrast similar to that of the Bragg dark field image, while the other one gave images with a contrast, which was reversed to that of the Bragg dark field image. (auth) (SWED)

44157 (UCRL-Trans-10129) NEGATIVE PHOTOEFFECTS IN SEMICONDUCTORS. Stockmann, F. Translated by J. M. Silberstein for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Phys., 143: 348-56(1955). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

When minority carriers are split by light off impurities in a semiconductor, electrical conductivity is reduced (negative photoeffect) if the above carriers combine sufficiently rapidly with free majority carriers. A quantitative formulation of the condition sufficiently rapidly leads to some very incisive requirements regarding the effective cross section of the impurity centers concerned. Such requirements are best met by those impurities that can be present in the lattice as double charged. This is the reason why negative effects, generally speaking, take place relatively infrequently, and also why they are observed remarkably frequently when a semiconductor contains impurities with two energy terms in the forbidden band. (auth)

44158 ADVANCES IN ELECTRONICS AND ELECTRON PHYSICS. VOLUME 23. Marton, L. (ed.). Advan. Electron. Electron Phys., 23: 1-490(1967).

Separate abstracts were prepared for five of the six reviews in this volume. The paper not abstracted individually is on noise in semiconductor devices. (A.G.W.)

For abstracts of individual papers see: 43700, 43895, 43947, 43948, and 44022.

44159 MAGNETOELASTIC EFFECTS AND THE MAGNETIC PROPERTIES OF RARE-EARTH METALS. Cooper, Bernard R. (General Electric Research and Development Center, Schenectady, N. Y.). Phys. Rev. Lett., 19: 900-3(Oct. 16, 1967).

It is shown that the driving force for the spiral-to-ferromagnet transition in Dy and Tb is the energy of cylindrical symmetry associated with the lowest-order magnetostriction effects. It is pointed out that the experimental temperature dependence of the spin-wave energy gap for Tb does not agree with that calculated using the frozen-lattice approximation suggested by Turov and Shavrov for magnetoelastic effects. (auth)

44160 MATERIAL EFFECTS OF LASER RADIATION AND BASIC INTERACTION PHENOMENA. Burkhalter, J. H. (Martin Co., Orlando, Fla.). Fed. Proc., 24: Transl. Suppl. 14, 31-4(Jan.-Feb. 1965).

Complete theoretical analysis of the interaction of high-intensity electromagnetic radiation with matter should include the effects of conduction, convection (mass transport), radiation (both thermal radiation and characteristic spectra), phase changes, thermoelastic shock effects, ionization phenomena, and photoelectric effects. Some simplified models for analysis are considered, with the realization that the results obtained will be useful guides only. The part played by heat is essential. Thus, conduction, convection, thermal radiation, and phase changes are direct heat effects, and the others are all thermally induced effects, at least to some degree. Most attention therefore is given to the study of the heat effects associated with the interaction. Among the situations considered are a laser pulse of small duration compared with the integration time of the material for 2 cases, namely, focused to a point, or uniformly distributed over an area, A. The only effect considered in first order is conduction. The domains of time and space considered are only those of times largely compared with the integration time and distances large compared with the characteristic absorption thickness or to the diffraction limits of the focused spot. These models correspond roughly to focused and unfocused Q-switched pulses. After derivation of some expressions relating thermal effects, methods of characterizing and measuring interactions are dealt with. In addition to heat effects, other important biologic effects of laser radiation, such as mechanical ones, are examined. (BBB)

44161 MAGNETISM OF PRASEODYMIUM METAL. Nagasawa, Hiroshi; Sugawara, Tadashi (Tokyo Univ.). J. Phys. Soc. Jap., 23: 701-10(Oct. 1967).

In order to investigate the magnetic behavior of praseodymium, measurements were made on the resistivity, the magnetoresistance, and the magnetic susceptibility of the metal and its dilute alloys. The parameters of the crystalline field splitting of the ground state of the Pr^{3+} ion in the d-hcp structure are estimated by analyzing the low temperature susceptibility of the dilute La–Pr alloys on the basis of the point charge model. The parameter of the exchange interaction between conduction electrons and Pr ion is estimated from the high temperature susceptibility data using the Ruderman–Kittel–Kasuya–Yosida theory. The magnetism of praseodymium metal, particularly the nature of the antiferromagnetic state, is discussed in terms of these parameters men-

tioned above. The conclusion obtained is: (a) the Pr ion at the cubic site of praseodymium has no magnetic moment at low temperature, and (b) the sinusoidal arrangement of the magnetic moment occurs only among the ions at the hexagonal site. The resistance minimum phenomenon observed in dilute Pr–Ce alloys seems to support this conclusion. (auth)

44162 MAGNETIC FIELD OF THE NUCLEUS ^{193}Ir IN COMPOUNDS OF IRIDIUM WITH RARE EARTHS. Heuberger, A.; Pobell, F.; Kienle, P. (Technische Hochschule, Munich). Z. Phys., 205: 503-16(1967). (In German).

The hyperfine splitting and isomer shift of the 73-keV γ transition in ^{193}Ir was measured in the intermetallic compounds $SmIr_2$, $GdIr_2$, $TbIr_2$, $DyIr_2$, $HoIr_2$, and $ErIr_2$ using the Mössbauer effect. The electric field gradients, the electron densities, and the magnetic fields at the Ir nuclei were deduced from these experiments. An extensive discussion of the internal magnetic fields is given in terms of an empirical model. (auth)

44163 OBSERVATION OF SPIN WAVES IN ERBIUM. Woods, A. D. B.; Holden, T. M.; Powell, B. M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Rev. Lett., 19: 908-10(Oct. 16, 1967).

The energy/wave vector spin-wave dispersion relation, $\hbar\omega(\vec{q})$, for the a and c directions in erbium metal in its conical magnetic phase was measured at 4.2°K using inelastic neutron scattering. These are believed to be the first observations of short-wavelength spin waves in such a structure. The results indicate that the anisotropy energy is much greater than the exchange energies, and that the interplanar exchange energies along the c axis are of oscillating sign as required for the stability of the structure of the spiral component. This behavior is very different from that found by Møller and Houmann (Phys. Rev. Letters, 16: 737(1966)) for ferromagnetic terbium, where succeeding interplanar exchange terms had the same sign. (TSS)

44164 PROFILES OF HIGH CONDUCTIVITY SHALLOW LAYERS IN SILICON PRODUCED BY BORON ION IMPLANTATION. Large, L. N.; Hill, H.; Ball, Mary P. (SERL, Baldock, Eng.). Int. J. Electron., 22: 153-64(Feb. 1967).

The conductivity profiles produced when boron ions are implanted into silicon were investigated as a function of ion energy, total ion flux and annealing schedule. The bombardments were carried out in a manner such that channelling was minimized. The profiles are compared with those predicted theoretically by Lindhard et al. (1963) for the bombardment of amorphous solids. At doping concentrations up to ~10^{18} acceptors/cm^3 the electrically active profile is in close agreement with the theoretical profile both as regards depth of the peak doping and the cutoff. At concentrations $\gtrsim 10^{20}$/cm^3 there is slight modification of the back edge of the profile, presumably due to channelling. The conductivity produced by a given annealing schedule was shown to be a function of the doping level, and the results are compared with those of Pavlov et al. (1965). The results show that this technique is capable of producing high-conductivity layers with a very high degree of control of doping profile and junction depth. (auth) (UK)

44165 THERMOLUMINESCENT STUDY OF THE COLOR CENTERS IN IRRADIATED POLYCRYSTALLINE MgO. Hecht, Harry G. (Los Alamos Scientific Lab., N. Mex.); Taylor, E. Donald. J. Phys. Chem. Solids, 28: 1599-1605(Aug. 1967).

Thermoluminescent measurements are reported on polycrystalline MgO samples containing the iron group ions, in an effort to determine the traps responsible for the luminescent transitions. Some of the traps were identified by this doping technique. The distribution of light emitted by each glow curve was determined by band pass filters, and the analysis of the glow curves by the Randall and Wilkins theory is discussed and the results reported. (auth) (UK)

44166 MAGNETIC SUSCEPTIBILITY OF Y–Tb DILUTE ALLOYS. Nagasawa, Hiroshi; Sugawara, Tadashi. (Tokyo Univ.). J. Phys. Soc. Jap., 23: 711-13(Oct. 1967).

The susceptibility of yttrium alloys, containing Tb ions of 0.60 to 3.71 at. %, has been measured in the temperature region from 1.4°K to room temperature. A systematic deviation of the Néel points from the $\xi^{\frac{1}{3}}$ dependence where ξ is the effective spin factor, was found. This deviation might be interpreted as due to the existence of a critical concentration of Tb ions for the appearance of a long-range magnetic spin ordering. From the Curie constants, the effective magnetic moment of 10.8 μ_B per Tb ion is obtained, which is larger than that for a free Tb^{3+} ion of 9.72 μ_B. The exchange interaction parameter between the conduction electron and the rare earth ion is estimated to be +0.15 eV, which agrees well with the results of the electronic transport phenomenon. (auth)

44167 MAGNETIC PROPERTIES OF GADOLINIUM–YTTRIUM ALLOYS. Belov, K. P.; Sointseva, L. I. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 69-72(Jan.-Feb. 1967). (In Russian).

Temperature dependence of magnetization, coercive force, and galvanomagnetic effect of gadolinium–yttrium alloys containing 10, 25, or 35% at yttrium has been investigated in magnetic fields of various intensities. Alloys were melted from 99.85%-pure gadolinium and 99.7%-pure yttrium and tested in the as-cast (rapidly cooled) or vacuum-annealed (at 600°C for 100 hr and slowly cooled) condition. It was found that in weak fields, the δ–T curves for the alloys tested show a maximum at about 180 to 200°K, similar to those observed previously in alloys with a higher yttrium content. In intensive fields this maximum disappears. In annealed alloys containing 35% yttrium, the maxima were observed in very weak fields only. Curves of the temperature dependence of coercive force show minima at about 200°K and maxima at about 250°C. It appears that the observed anomalies are due to the annihilation of the noncollinear configuration of magnetic moments existing in these alloys. Approximately the same thing occurs in pure gadolinium. (ATD)

44168 DYNAMICAL THEORY OF THE INTERACTION OF X RAYS AND NEUTRONS WITH PHONONS. O'Connor, D. A. (Univ. of Birmingham, Eng.). Proc. Phys. Soc. (London), 91: 917-27(Aug. 1967).

The interaction of x rays and neutrons with phonons in perfect crystals is treated by the methods of the dynamical theory of x-ray diffraction. It is found that phonon-scattering processes make a contribution to both the real and imaginary parts of the refractive index of the crystal. The intensity of the phonon-scattered peaks is calculated, and it is found that in the absence of elastic scattering the expressions for the intensity reduce essentially to those given by the kinematic theory. When the incident wave can be elastically scattered (at a Bragg angle), then the spatial variation of the amplitudes of the incident and elastically scattered waves is the dominant factor in deciding the amplitudes of the phonon-scattered waves. Thus in the Bragg reflection condition the phonon peaks are reduced in intensity owing to primary extinction, and the intensity of the inelastic scattering is asymmetrically distributed about the Bragg peak. In the Laue reflection condition the Pendellösung fringes in the elastically scattered waves are accompanied by a similar but less marked variation in the inelastically scattered waves, and the Borrmann effect of anomalous transmission also has its counterpart in the phonon scattering. The anomalously low absorption coefficient in the Borrmann effect will have a temperature-dependent contribution due to inelastic scattering. Some of these effects should be observable experimentally if methods are used to distinguish elastically and inelastically scattered radiation. (auth)

44169 DISPLACEMENT CASCADES IN DIATOMIC SOLIDS. Felder, R. M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys. Chem. Solids, 28: 1383-92(Aug. 1967).

Displacement cascade equations are derived and solved for a structureless diatomic solid in which displacements produced by irradiation occur according to a modified Kinchin–Pease model. Quantitative estimates are obtained for the influence on the cascade of a difference in the displacement threshold energies of the two atomic species. It is found that the number of displacements of either species produced by a primary atom depends strongly on the ratio of the displacement energies, but that the total number of displacements produced is relatively insensitive to this quantity. (auth)

44170 GROUP THEORETICAL SELECTION RULES IN INELASTIC NEUTRON SCATTERING. Elliott, R. J.; Thorpe, M. F. (Univ. of Oxford). Proc. Phys. Soc. (London), 91: 903-16 (Aug. 1967).

The intensity of neutron inelastic scattering by phonons is considered, using the symmetry properties, by group theoretical methods and the extension to scattering by magnons is briefly discussed. In some circumstances there are selection rules forbidding scattering at particular K values and, by examining the phonons at a series of points $K = k + G$ for different reciprocal lattice points G, it is often possible to make a definite symmetry identification of the various branches. It is hoped that the results will be of use in the interpretation of experimental data in more complicated crystals than have so far been studied. The fluorite and cuprite structures are considered as examples that might be profitably investigated. Standard projection operator techniques are employed. (auth)

44171 NUCLEAR COOLING WITH INDIUM AND NUCLEAR QUADRUPOLE INTERACTION. Symko, O. G. (Oxford Univ.). Phys. Lett., 25A: 385-6(Sept. 11, 1967).

Nuclear adiabatic demagnetization experiments with indium

have resulted in cooling its nuclear spins, its lattice, and a copper specimen in contact with it. The experiments show that, because of the nuclear quadrupole interaction, the indium spins have a large rate of heat absorption and are particularly well suited for nuclear refrigeration. (auth)

44172 COMPARABILITY OF HYPERFINE COUPLING FIELDS MEASURED IN ALLOYS PREPARED BY ION IMPLANTATION AND BY MELTING OR DIFFUSION. Reid, P. G. E. (Oxford Univ.); Sott, M.; Stone, N. J.; Spanjaard, D.; Bernas, H. Phys. Lett., 25A: 396-8(Sept. 11, 1967).

Hyperfine interactions of ^{198}Au and ^{122}Sb implanted in iron are compared with those in normally prepared alloys. Nuclear orientation measurements show that H_{eff} is usually reduced in implanted sources though in some cases the full value can be obtained. (auth)

44173 INDIRECT EXCHANGE INTERACTION IN THE RARE-EARTH METALS. Specht, Frederick (Rice Univ., Houston, Tex.). Phys. Rev., 162: 389-98(Oct. 10, 1967).

With a free-electron model for the conduction band, the isotropic and first-order nonisotropic terms of the indirect exchange interaction in the rare-earth metals have been calculated exactly (in second-order perturbation). The results are compared with previous treatments of the problem, all of which utilize some type of approximation, and specifically with the calculation of Kaplan and Lyons (KL), who assume that the exchange integral $\mathcal{J}(k,k')$ depends only on $k-k'$. It is found that the exact calculation leads to results in disagreement with the approximate treatments: The nonisotropic term is about 4 times larger than that of KL, and the radial dependence of the interaction is significantly different. The resulting Hamiltonian predicts a ferromagnetic ordering pattern for gadolinium at 0°K, while the approximate theories predict a screw structure. However, the predicted ordering pattern for Gd is extremely sensitive to changes in the Fermi wave vector k_F. A 5% increase in k_F stabilizes a screw structure with a turn angle of 20°. An estimate is given of the relative contribution of the anisotropic term (relative to the isotropic) for the ferromagnetic ordering pattern. For the two-ion asymptotic interaction, this effect is found to be quite large, ranging from 35 to 200% among the heavy rare earths and over the values of k_F considered. After being summed over the lattice, the contribution is cut down by roughly an order of magnitude. (auth)

44174 HALL EFFECT OF GADOLINIUM, LUTETIUM, AND YTTRIUM SINGLE CRYSTALS. Lee, R. S.; Legvold, S. (Iowa State Univ., Ames). Phys. Rev., 162: 431-5(Oct. 10, 1967). (IS-1522).

Hall-effect measurements have been made on single crystals of gadolinium (hcp) in magnetic fields up to 30 kOe applied along the [11$\bar{2}$0] (a axis), [10$\bar{1}$0] (b axis), and [0001] (c axis) directions. The temperature range covered was 4.2 to 340°K. Large anisotropy and strong temperature dependence were observed for both the ordinary Hall coefficient, and the extraordinary Hall coefficient. These results are interpreted in terms of Fermi-surface anisotropy and exchange splitting of the conduction band. Hall-effect measurements have been made on single crystals of lutetium (hcp) and yttrium (hcp) in magnetic fields up to 7.8 kOe applied along the a, b, and c axes. The temperature range covered was 8 to 320°K. The Hall coefficients of these metals showed large anisotropy and strong temperature dependence. The anisotropy is interpreted in terms of Fermi-surface anisotropy and the temperature dependence is explained in terms of a transition from impurity scattering at low temperatures to scattering from photons at high temperatures. (auth)

44175 CALCULATION OF NEUTRON AND X-RAY SCATTERING AMPLITUDES FOR bcc IRON. DeCicco, P. D.; Kitz, A. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 162: 486-91(Oct. 10, 1967).

The charge and spin densities for bcc iron were obtained from Bloch wave functions calculated by the augmented-plane-wave (APW) method. An interative spin-dependent Hartree–Fock–Slater calculation was carried out and was found to yield a total spin per unit cell considerably in excess of the experimental value. The APW method was also applied to the potential of Wakoh and Yamashita, and the x-ray- and neutron-scattering amplitudes were calculated from the resulting charge and spin densities for direct comparison with experiment. The neutron amplitudes are in reasonable agreement with experiment, and the calculated spin density confirms the existence of a region of negative magnetization density inferred from experiment. The x-ray amplitudes for paired reflections indicate a much more nearly spherical charge distribution than do the experimental values. The sensitivity of these results to the potential used and the question of self-consistency have been investigated. (auth)

44176 MOESSBAUER EFFECT OF ^{125}Te IN SIMPLE-CUBIC AND AMORPHOUS TELLURIUM-BASE ALLOYS. Tsuei, C. C.; Kankeleit, E. (California Inst. of Tech., Pasadena). Phys. Rev., 162: 312-14(Oct. 10, 1967).

Recoilless resonant absorption of the 35.6-keV γ ray ($\frac{3}{2}^+$ to $\frac{1}{2}^+$ transition) in ^{125}Te has been observed in both simple-cubic and amorphous tellurium-base alloys obtained by rapid cooling from the liquid state. As expected from its cubic symmetry, the simple-cubic (one atom/unit cell) metastable $AuTe_2$ gives a single-peak Mössbauer spectrum with a half-width 0.88 ± 0.05 cm/sec and an isomeric shift of 0.03 ± 0.01 cm/sec. The monoclinic $AuTe_2$, which is the equilibrium form of this compound, unexpectedly shows also a single-peak spectrum with an isomeric shift 0.04 ± 0.01 cm/sec. However, the latter is about 23% broader than the former. On the basis of the atomic arrangement of the monoclinic $AuTe_2$, this line broadening is attributed to a weak quadrupole interaction. These findings are consistent with the fact that both polymorphs exhibit metallic conduction of the same order of magnitude. The Mössbauer spectrum of the metastable amorphous alloy $Te_{70}Cu_{25}Au_5$ exhibits a well-resolved quadrupole splitting of 0.74 ± 0.02 cm/sec, which is about the same as that of crystalline tellurium. The fact that the amorphous alloy has a quadrupole splitting of the same magnitude as that of crystalline tellurium confirms the hypothesis proposed previously that the metastable amorphous tellurium-base alloys consist of randomly oriented spiral chains of tellurium, with the atoms of the minor constituent(s) randomly distributed between the chains. As a consequence of the chain retention in the amorphous alloy, there is predominantly a covalent bonding like that in crystalline tellurium. This conclusion offers a possible explanation of the experimental fact that the amorphous alloy shows a semiconducting behavior similar to that of crystalline tellurium. (auth)

44177 NEUTRON-DIFFRACTION STUDY OF THE MAGNETIC LONG-RANGE ORDER IN Tb. Dietrich, O. W.; Als-Nielsen, J. (Danish Atomic Energy Commission, Riso, Denmark). Phys. Rev., 162: 315-20(Oct. 10, 1967).

Like other heavy rare-earth metals, Tb exhibits a magnetic phase with a spiral structure. This appears within the temperature region from 216 to 226°K between the ferromagnetic phase and the paramagnetic phase. The transition between ferromagnetic and spiral structure is of first order and implies no change in the long-range order. In the close vicinity of the Néel temperature T_N = 226°K the spiral magnetic long-range order varies as $(T_N-T)^{0.25\pm0.01}$, whereas the total order within a wider temperature range roughly follows $(T_N-T)^{1/3}$. The turn angle per layer varies from 16.5° at 216°K to 20.7° at 226°K. The temperature variation of the transverse magnetostriction has also been measured and was found to vary approximately in proportion to the square of the magnetic long-range order. (auth)

44178 NUCLEAR SPIN–LATTICE RELAXATION IN HEXAGONAL TRANSITION METALS: TITANIUM. Narath, Albert (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 162: 320-32(Oct. 10, 1967).

The nuclear magnetic resonance to ^{47}Ti and ^{49}Ti has been observed in hexagonal close-packed titanium metal in the temperature range 1 to 4°K. Measurements of the line profile and relaxation rates were carried out at 12.5 MHz by pulsed nuclear resonance techniques. Since the gyromagnetic ratios of ^{47}Ti and ^{49}Ti are nearly identical, the resonances of the two isotopes were superimposed. A partially resolved first-order quadrupole spectrum having a total width exceeding 8 kOe was observed, yielding a probable assignment $h^{-1}e^2qQ^{47} \approx h^{-1}e^2qQ^{49} \approx 7.7$ MHz. The average Knight shift is estimated to be $K = (+0.4 \pm 0.2)\%$. The spin–lattice relaxation times T_1, which are quite long (T_1T = 150 ± 20 sec°K), provide evidence that the conduction-electron states at the Fermi level are predominantly d-like. The theory of nuclear spin–lattice relaxation in hexagonal transition metals is treated in the tight-binding approximation. Contact, core-polarization, orbital, and dipolar hyperfine interactions are considered. The magnitudes of the orbital and dipolar contributions to the spin–lattice relaxation rate depend on the orientation of the magnetic field relative to the hexagonal c axis. In the presence of s–d mixing, the contact contribution is found to interfere destructively with one of the components of the core-polarization contribution. The predicted total relaxation rates are shown to depend more strongly on the orbital admixture coefficients than is the case in cubic transition metals. The relatively large number of parameters in the theory precludes a unique fit to the experimental results for titanium. In general, however, the calculated rates exceed the observed rate by a factor of 2 to 3 over a wide range of parameter values. The apparent discrepancy is attributed to the combined effects of (1) the electron–phonon enhancement of the electronic specific heat and (2) s–d interference effects. The former effect causes the "bare" electron density of states

to be overestimated, while the latter leads to an overestimate of the sum of contact and core-polarization contributions to the relaxation. (auth)

44179 MOESSBAUER SPECTRA OF FeMo ALLOYS. Marcus, H. L. (Texas Instruments, Attleboro, Mass.); Schwartz, L. H. Phys. Rev., 162: 259-62(Oct. 10, 1967).

Moessbauer spectra of Fe–Mo alloys have been obtained for a series of closely spaced compositions from 2.1 to 6.0 at. % Mo. The hyperfine field and peak widths show a composition dependence suggestive of overlap of the disturbed surroundings of impurity atoms, in accord with results of neutron-diffraction studies of dilute impurities in iron. Analysis of the data in conjunction with the recent unpublished magnetization results of Aldred led to the deduction of a fractional increase in average iron magnetic moment, $(1/\mu_{Fe})\ (d\mu_{Fe}/dC)$, of 0.25 per at. % and a magnetic moment per Mo atom of $0.4\mu_B$ directed antiparallel to the iron moment, the latter value in good agreement with the neutron-diffraction results. (auth)

44180 TIME DEPENDENCE OF RECOIL-FREE RSONANCE FOLLOWING ELECTRON CAPTURE IN ^{57}Co. Triftshaeuser, Werner (Technische Hochschule, Munich); Craig, Paul P. Phys. Rev., 162: 274-85(Oct. 10, 1967). (BNL–10969).

The use of delayed-coincidence techniques in conjunction with the Mössbauer effect permits measurements of the time evolution of the Mössbauer resonance following formation of the resonant nuclear level. A series of measurements are reported in which time dependence of ^{57}Fe chemical charge states was studied for sources of ^{57}Co (which decays to ^{57}Fe) embedded in various compounds: CoO, NiO, $Fe(NH_4)_2(SO_4)_2 \cdot 6H_2O$, $CoSO_4 \cdot 7H_2O$, and $CoCl_2.4H_2O$. These are systems in which the resonance spectra had previously been interpreted in terms of metastable chemical charge states possessing lifetimes comparable to the nuclear life time (100 nsec). In no case were time effects observed that could not be attributed to "time filtering" of the emitted radiation by the resonant absorber. The appearance of multiple emission lines is interpreted in terms of equilibrium between ferric and ferrous ions, the relative intensities probably being determined by the amount of deviation of the samples from stoichiometry. (auth)

44181 CHARGE CONVERSION OF IRRADIATED RARE-EARTH IONS IN CaF_2. II. THERMOLUMINESCENT SPECTRA. Merz, J. L.; Pershan, P. S. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 162: 235-47(Oct. 10, 1967).

High-resolution emission spectra are observed for individual glow peaks from all the lanthanide ions in CaF_2. The crystals are irradiated with x rays (or γ rays) at 77° and subsequently heated. For a given ion, identical spectra are observed for all glow peaks below 300°K. In all cases where the spectra can be interpreted, the ions responsible for these glow peaks are in sites of cubic symmetry. For some of these ions this is the first time that cubic emission has been seen without the complication of accompanying emission from sites of lower symmetry. The emission above room temperature is always from ions of axial symmetry, which for Gd^{3+} has been identified as tetragonal. Comparison is also made between Gd^{3+} in CaF_2, SrF_2, and BaF_2. In the last two cases both cubic and trigonal symmetry are observed below room temperature. (auth)

44182 CHARGE CONVERSION OF IRRADIATED RARE-EARTH IONS IN CALCIUM FLUORIDE. I. Merz, J. L.; Pershan, P. S. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 162: 217-35(Oct. 10, 1967).

The mechanism by which the rare-earth ions in CaF_2 can be reduced from the trivalent to the divalent state by exposure to x rays or γ rays has been systematically studied for all the thirteen available ions in the lanthanide series. Each of the ions was irradiated at 77°K and its temperature subsequently raised above room temperature. During the heating process the intensity of the thermoluminescence and the changes in the optical absorption spectrum were measured as a function of temperature. An accompanying paper describes the changes in the emission spectrum with temperature. In general, the temperatures at which significant changes in absorption occur, and for which there is simultaneous thermoluminescent emission, are independent of the particular rare-earth ion, while the emission spectra are characteristic of the rare earth. The absorption spectra have parts characteristic of the individual ions and parts independent of the ion. On the basis of these observations, it is possible to formulate a consistent model of the irradiation-induced charge-reduction process and the subsequent thermal reoxidation process. From 77 to about 330°K the oxidation process is attributed to thermal activation of a variety of hole traps. (auth)

44183 LATTICE PARAMETER CHANGES IN LOW-TEMPERATURE X-IRRADIATED KCl. Hertz, W.; Peisl, H.; Waldelich, W. (Technische Hochschule, Darmstadt, Ger.). Phys. Lett., 25A: 403-4(Sept. 11, 1967).

Lattice parameter changes were studied in KCl during x irradiation at 8°K and after thermal annealing. Thermal annealing takes place in distinct recovery stages, their relative magnitude depending on the irradiation dose. (auth)

44184 RARE-GAS DIFFUSION IN NEUTRON-IRRADIATED POTASSIUM HALIDES. Felix, F. W. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Proc. Brit. Ceramic Soc., No. 9, 273-8(July 1967).

The release of ^{41}Ar and ^{39}Ar from irradiated single crystals of potassium halides was measured in the temperature range 150°C to the melting point and over the dose range 1×10^{13} to 3.4×10^{16} (10^{19} for KF) fast neutrons/cm^2. The activation energies, attributed to an interstitial diffusion mechanism, for KF, KCl, KBr, and KI are 1.8, 0.32, 0.36, and 0.30 eV, respectively. KCl, KBr, and KI showed a stronger temperature dependence below about $^2/_3$ of the absolute melting point, i.e., 2.45, 1.80, and 0.97 eV, respectively, attributed to the trapping effect of intrinsic defects. At higher doses, new effects were observed, indicating extrinsic and probably clustered defects, with the exception of the dose-independent KF. (auth)

44185 HIGH-RESOLUTION MEASUREMENTS OF THE DIFFUSION OF INERT GAS IN $\alpha-Al_2O_3$. Jech, Cestmir (Inst. of Physical Chemistry, Prague); Kelly, Roger. Proc. Brit. Ceramic Soc., No. 9, 259-72(July 1967).

New experiments are reported on inert-gas diffusion in ion-bombarded $\alpha-Al_2O_3$ in which it has been attempted to achieve a higher degree of resolution than in previous work. The measurements were of the type in which the gas-release rate (dF/dt) is followed while the temperature of the specimen increases linearly. Release starting at 850 to 1000°C was identified as stage II, i.e. as occurring at temperatures broadly compatible with self-diffusion, on the basis of the electron-microscope studies of Drum and Wilks et al., in which the temperatures for the beginning of loop annealing were established. A process maximizing at 700 to 760°C, which is known to be connected with the amorphous–crystalline transition, was shown to have unexpected counterparts in the annealing of colour centres and density changes. Further low-temperature release at 100 to 550°C was found to consist of two substages. The second of these (maximum at 415 to 465°C) has counterparts in a variety of annealing phenomena, and is tentatively attributed to excess point defects. The first substage (maximum at 180 to 230°C) may possibly involve surface proximity in some way, though comparisons can also be made with the first stage of colour centre annealing and with the motion of oxygen interstitials. The following ΔH's were obtained by assuming single-jump kinetics with a discrete ΔH and using $\Delta H/T$ formulas as developed in previous papers: 77 ± 2 kcal/mole for the process associated with the amorphous–crystalline transition, 54.5 ± 2 kcal/mole for the process tentatively attributed to excess point defects, and 36.5 ± 2 kcal/mole for the process maximizing at 180 to 230°C. (auth) (UK)

44186 INERT-GAS DIFFUSION AS A PROBE FOR LATTICE DEFECTS IN IONIC CRYSTALS. Kelly, Roger (EURATOM, Ispra, Italy); Jech, Cestmir. Proc. Brit. Ceramic Soc., No. 9, 243-58(July 1967).

Although inert-gas diffusion in solids can be studied as an end in itself, having a particular importance in nuclear technology, it is also possible to regard the motion of the inert gas as a probe for defects. The connection between inert-gas behavior and the defect structure of the host solid arises in part from the extensive disordering which inevitably accompanies the introduction of inert gas into a solid, and in part from the presence of the inert gas itself. The four principal types of defects which occur are discussed and a variety of examples given involving ionic crystals, to illustrate these types. Excess point defects are shown to play a tentative role with UC and $\alpha-Al_2O_3$, the evidence in the latter case being that the release process at 375 to 550°C has temperature agreement with that for point-defect motion. Bombardment-induced amorphousness is well established as the cause of gas release in $\alpha-Al_2O_3$ at 600 to 800°C, and it is argued that analogous release occurs with $\alpha-Fe_2O_3$ and $\alpha-Cr_2O_3$ at 450 to 600°C. The phenomenon of weak trapping, which is believed to involve transient gas-damage or gas-gas interactions, seems to bring about higher release temperatures with KCl but lower release temperatures with MgO. Although a formal correlation between gas transport and bubble diffusion has been undertaken only with Pt, there is good evidence that the formation and motion of bubbles also play a role with $\alpha-Al_2O_3$. (UK)

44187 MEASUREMENT OF ANIONIC DIFFUSION IN KBr BY MEANS OF ISOTOPIC EXCHANGE. Dawson, D. K.; Barr, L. W. (Atomic Energy Research Establishment, Harwell, Eng.). Proc. Brit. Ceramic Soc., No. 9, 171-80(July 1967).

The validity of the assumptions normally made in using the isotopic exchange technique for measuring diffusion was verified experimentally for the case of bromine diffusion in KBr. For this purpose a sensitive chemical sectioning technique was developed. Bromine diffusion in KBr single crystals while homogeneous, was shown to be strongly influenced by the presence of dislocations and grain boundaries. The activation energy for intrinsic diffusion is 2.61 eV atom^{-1} and for dislocation and grain-boundary diffusion 1.49 eV atom^{-1}. It is also shown that bromine diffusion is independent of the ambient bromine pressure. (auth) (UK)

44188 THE SPECTRAL EMISSION FROM LiF DURING THERMOLUMINESCENCE. **Townsend, P. D. (Picatinny Arsenal, Dover, N. J.).** Proc. Brit. Ceramic Soc., No. 9, 125-30(July 1967).

The emission spectra of the most intense thermoluminescence peaks in lithium fluoride were measured with a rapid-scanning monochromator. Crystals showing individual peaks produced complex and different emission spectra for the peaks at 133, 147, 154, and 255°K. In the thermoluminescence curves the spectrum of each peak exhibited several emission maxima. Emission maxima were found at wavelengths of 3000, 4200, 4800, 5000, and 6000Å. Consequently, the emission from samples containing several overlapping thermoluminescence peaks changed as the crystal was heated. Changes were also produced in the emission spectrum by different irradiation doses, even for an isolated thermoluminescence peak. (auth) (UK)

44189 ELECTRON SPIN RESONANCE AND OPTICAL STUDIES OF LOW-TEMPERATURE RADIATION EFFECTS IN LEAD HALIDE CRYSTALS. **Patankar, A. V.; Schneider, E. E. (Univ. of Newcastle-upon-Tyne, Eng.).** Proc. Brit. Ceramic Soc., No. 9, 97-108(July 1967).

The γ-irradiation of planar lead halides at liquid-nitrogen temperature produces color centres by trapping electrons and holes in isolated vacancies or in vacancy clusters. The exchange-narrowed spin-resonance lines, with g values of 1.999 and 2.006 assigned to electron and hole centres, respectively, have powder-like shapes which are attributed to a quasi-vitreous environment of the sites where centres are formed. This distortion produced by irradiation persists even after bleaching, as shown by the orientation-independent spectrum of the bleach products. Electron-microscope observation in γ-irradiated crystals shows the presence of distortions demonstrated by a "mottling" of an average size 600Å. In γ-irradiated PbI_2 two optical absorption peaks are observed at 1.5 μM and 4 μM, which are assigned to the electron and hole centres, respectively. Irradiation centres in β-PbF_2 give a complex orientation-dependent spectrum which is associated with localized centres. (auth) (UK)

44190 OPTICAL ABSORPTION STUDIES OF COLOUR CENTRES IN HEAVILY IRRADIATED MAGNESIUM OXIDE. **King, R. D.; Henderson, B. (Atomic Energy Research Establishment, Harwell, Eng.).** Proc. Brit. Ceramic Soc., No. 9, 63-72(July 1967).

Optical absorption bands in high-dose (> 10^{19} nvt) neutron-irradiated MgO were observed to grow simultaneously with a decay in the F-centre concentration upon annealing. Zero-phonon lines associated with some of these bands were examined under uniaxial stress, and the defects responsible for the lines found to have symmetry axes analogous to those for the M, R, and N centres in the alkali halides. The defect responsible for a line at 5248Å has trigonal symmetry and exhibits dichroism indicative of an E → A electronic transition. This behavior closely resembles that for the R centre, but for electrostatic reasons it is argued that the defect contains at least five electrons. Lines at 6419Å and 6490Å, also associated with trigonal centres, but with A ground states, may be the analogues of R centres with yet again different electronic populations. The optical bleaching of the ESR signal associated with an F centre is most efficient at 3.7 eV. The original model for this defect was a cation–anion vacancy pair containing a trapped electron, and a simple calculation for this model suggests that the bleaching transition is from a single bound state to the conduction band. (auth) (UK)

44191 SYMMETRY PROPERTIES OF DEFECTS STUDIED BY UNIAXIAL STRESS SPECTROSCOPY. **Hughes, A. E. (Atomic Energy Research Establishment, Harwell, Eng.).** Proc. Brit. Ceramic Soc., No. 9, 51-62(July 1967).

Under favorable conditions of small electron-lattice coupling and low temperatures the electronic spectrum of a defect may show sharp zero-phonon lines whose width is caused mainly by residual lattice strains and is usually a few cm^{-1}. This is narrow enough to detect resolvable splittings of the line by an applied perturbation such as uniaxial stress, and to allow the subsequent determination of the symmetry of the defect and its electronic states. A description of the types of defect symmetries which may occur in cubic crystals, and a general survey of the theory of stress spectra is presented, emphasizing the physical principles rather than pursuing any specific case in detail. Some recent experimental applications of the technique are briefly reviewed. (auth) (UK)

44192 NEW APPROACH TO THE ISING MODEL. II. **Gibberd, R. W.; Hurst, C. A. (Univ., Adelaide).** J. Math. Phys. (N. Y.), 8: 1427-35(July 1967).

Onsager's results for the partition and correlation functions for the Ising model on a two-dimensional rectangular lattice are rederived using a Green's function technique. The definition of the Green's function is based on a recently published casting of the Ising model into a many-body fermion problem. The relation between this approach and other methods used for solving the Ising problem are indicated. (auth)

44193 LOGARITHMIC DENSITY BEHAVIOR OF A NON-EQUILIBRIUM BOLTZMANN GAS. **Goldman, Robert (Univ. of Maryland, College Park); Frieman, Edward A.** J. Math. Phys. (N. Y.), 8: 1410-26(July 1967).

The temporal evolution of the BBGKY hierarchy in the Boltzmann approximation for spatially homogeneous nonequilibrium situations is considered, in the absence of initial correlations. For times of the order of the mean free time or greater, the single particle function f_1 is found to be of the form $f_1 = f_1^0 + \epsilon f_1^1 + \epsilon^2 |\ln \epsilon| \tilde{f}_1^1 + O(\epsilon^2)$ with $\epsilon = nr_0^3$ (n is the density, r_0 the range of binary interaction) and f_1^0, f_1^1, and $\tilde{f}_1^1$ of order unity. For times less than the mean free time, with t in units of the duration of a binary interaction, f_1 is of the form $f_1 = f_1^0 + \epsilon f_1^1 + \epsilon^2(\ln t)\tilde{f}_1^1 + O(\epsilon^2)$. In both cases the same formally higher-order binary correlation functions are neglected. (auth)

44194 CRITERION FOR BOSE–EINSTEIN CONDENSATION AND REPRESENTATION OF CANONICAL COMMUTATION RELATIONS. **Ezawa, Hiroshi (Univ. of Wisconsin–Milwaukee, Milwaukee); Luban, Marshall.** J. Math. Phys. (N. Y.), 8: 1285-1311(June 1967).

The existence of a Bose–Einstein condensation in an interacting many-boson system at T = 0°K is proved under certain conditions on the particle density and the interparticle potential. Starting with the tentative assumption that the condensation exists, we study the fluctuation in the occupation number of the condensate with due regard to its interactions (1) with particles outside the condensate as well as (2) with the fluctuation itself. If the condensate fluctuation has a normalizable ground state, then the assumed existence of the condensation is tenable. For the case of the pair-Hamiltonian model satisfying the conditions for condensation, the interactions of the second category are of no importance. In the limit of infinite volume, this Hamiltonian can be diagonalized in an irreducible representation of a Bose-field operator $\phi(x)$, where $\phi(x)$ has nonvanishing ground state expectation value, in accordance with the usual c-number replacement of creation and destruction operators for the condensate particles. The full Hamiltonian for a system of pairwise interacting bosons is studied only in a low-density limit. Bose-Einstein condensation exists when the overall space integral of the interparticle potential is positive. In this case the interactions of the second category play an important role in ensuring a normalizable ground state for the condensate fluctuation. There is an indication that in the limit of infinite volume the Hamiltonian cannot be diagonalized in any irreducible representation of the field operator ϕ. Yet the c-number replacement of the condensate operators is legitimate as far as states of particles outside the condensate are concerned. Some speculations are made as to what may happen for systems of moderate density. (auth)

44195 MEASUREMENT OF THE EFFECTIVE MAGNETIC FIELDS ON ^{60}Co NUCLEI IN DILUTE SOLID SOLUTIONS OF Co IN Pd. **Parfenova, V. P.; Alekseevskii, N. E.; Erzinkyan, A. L.; Shpinel, V. S. (Inst. of Nuclear Physics, Moscow).** Zh. Eksp. Teor. Fiz., 53: 492-7(Aug. 1967). (In Russian).

The effective magnetic fields on ^{60}Co nuclei in Co–Pd alloys are measured by the oriented nuclei technique. Dilute solid solutions of Co in Pd were investigated for Co concentrations of 8.3, 2.0, 0.3, 0.1 and 0.03 at. %. The field strengths on ^{60}Co nuclei in the Co–Pd alloy are compared with the magnetic field strength acting on the Co nucleus in metallic Co. With decrease of the Co concentration from 8.3 to 0.1 at. % the field on the ^{60}Co nucleus first increases and then drops at a concentration of 0.03 at. %. At the lowest concentration investigated (0.03 at. % of Co) the alloy retains its ferromagnetic properties. (auth)

44196 PROTON SCATTERING ON A TUNGSTEN SINGLE CRYSTAL. **Kulikauskas, V. S.; Malov, M. M.; Tulinov, A. F. (Inst. of Nuclear Physics, Moscow).** Zh. Eksp. Teor. Fiz., 53: 487-9(Aug. 1967). (In Russian).

Scattering of 500-keV protons on a tungsten single crystal is investigated experimentally. A strong depression of the intensity of the scattered particles is observed if conditions of channeling along the [100] axis and shading along the [111] axis are fulfilled simultaneously. Some possibilities of using this phenomenon for determining the degree of perfection of the lattice are discussed. (auth)

44197 MOTT AND WIGNER TRANSITIONS. Kohn, W. (Univ., Paris. Univ. of California, San Diego, La Jolla). Phys. Rev. Lett., 19: 789-91(Oct. 2, 1967).

Wigner earlier pointed out that the ground state of a system of interacting electrons in a uniform charge background has a completely different character in the low- and high-density limits. A basic approach to the theory of these high-to-low density transitions is outlined. (M.O.W.)

44198 NEUTRON-INDUCED TYPE CHANGES IN P-TYPE SILICON. Urli, N. B.; Persin, M. J. Phys. Chem. Solids, 28: 1627-9(Aug. 1967).

Reactor neutrons were used as a source of damage in high-purity p-type silicon crystals, as well as in lithium-compensated silicon material. Effects of irradiation were determined by electrical and optical measurements. Hall coefficient measurements revealed that p-type samples change into n-type by introducing a deep donor level situated at 0.55 eV below the conduction band, after irradiation. Another deep level, at 0.47 eV below the conduction band, was detected in lithium-doped samples after neutron irradiation. (UK)

44199 FERROMAGNETIC RESONANCE OF ^{3}He-IRRADIATED THIN METAL FILMS. Bailey, G. C. (Naval Research Lab., Washington, D. C.); Schindler, A. I.; Meijer, P. H. E. J. Appl. Phys., 38: 4004-12(Sept. 1967).

Ferromagnetic resonance measurements at 9.5 Gc were made on a number of films of pure iron, pure nickel, and alloys of iron and nickel (Permalloy) before and after 2-MeV ^{3}He-particle irradiation. The ^{3}He particle flux was about 3×10^{17}/cm^2 and, during irradiation, the film temperature did not exceed 81°C, as determined by thin-film thermocouples. The resonance field as a function of angle in the film plane, $H_0(\theta)$, and the half-width, ΔH, were measured at room temperature. In general, H_0 decreased (by about 2, 35, and 15 Oe for the iron, Permalloy, and nickel films, respectively) as a result of the irradiation, except for the composition range between 26% and 37% Ni where H_0 increased. Also, the half-width generally decreased with irradiation and the half-width change was smallest for compositions around 76% Ni. The changes in H_0 were different for films of a given set evaporated onto various substrates (soft glass, fused quartz, single-crystal quartz). Irradiating films in a saturating magnetic field, in the remanent state, and in the demagnetized state gave H_K's which were larger, the larger the magnetic induction of the film during irradiation. Irradiating a film (or reirradiating a previously irradiated film) in a magnetic field also rotated the easy axis of the film into the direction of the field applied during irradiation. The rotation of the easy axis was observed over the entire composition range from pure iron to pure nickel. The variation with composition of the values of H_K after irradiation agrees qualitatively with the values obtained by others using static techniques. (auth)

44200 TIME AND TEMPERATURE DEPENDENCE OF IRRADIATION EFFECTS IN SOLID DIELECTRICS. Brown, R. G. (E. I. du Pont de Nemours and Co., Wilmington, Del.). J. Appl. Phys., 38: 3904-7(Sept. 1967).

Decay of the electron distribution injected into a polymeric solid at 2 MeV was investigated by measuring the charge released during a triggered discharge. From the decay time constant $\tau = \rho\epsilon$, resistivity ρ was calculated. For polymethylmethacrylate, the variation of ρ with temperature yielded an activation energy or trap depth $W \approx 0.6$ eV. Discharges resulting in Lichtenberg figures were also produced in polystyrene and polypropylene. Trap depths were estimated to be $W \approx 0.6$ eV for polystyrene and $W \gtrsim 0.4$ eV for polypropylene. (auth)

44201 ELECTRON TRAPS FORMED IN GALLIUM-DOPED GERMANIUM BY ELECTRON IRRADIATION. Fukuoka, N. (Osaka Univ.); Saito, H., Hattori, H.; Crawford, J. H. Jr. J. Appl. Phys., 38: 4098-9(Sept. 1967).

Isochronal anneals were carried out on p-type (Ga-doped) Ge which was irradiated by 1.5-MeV electrons at 77°K. Five annealing stages occur between 77 and 400°K, with two minority-carrier traps annealing below room temperature. The stage between 100 to 150°K can be attributed to thermal release of trapped electrons, and its trapping level was found to be located at $E_c - 0.16$ eV. A deep trapping center remains stable to 270°K, and its level is $E_v + 0.16$ eV. After annealing at 270°K, no electrons were released from the traps, suggesting destruction of the deep traps. (D.L.C.)

44202 RANGES OF Na, K, Kr, AND Xe IONS IN AMORPHOUS Al_2O_3 IN THE ENERGY REGION 40 TO 1000 keV. Jespersgard, P.; Davies, J. A. (Univ. of Aarhus, Denmark). Can. J. Phys., 45: 2983-94(Sept. 1967).

Range distributions of ^{24}Na, ^{42}K, ^{85}Kr, and ^{133}Xe ions in amorphous Al_2O_3 were measured in the energy region 40 to 1000 keV. The experimentally observed values of the mean range and range straggling are in excellent agreement with the predictions of Lindhard et al. (1963), except at the higher energies, where the observed ranges are consistently larger than the predicted values. (auth)

44203 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED GLASSES OF Na_2O-TeO_2 SYSTEM. Mikhailova, T. G. (Siberian Physical-Technical Inst., Tomsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 128-9(1967). (In Russian).

Studies were made of the EPR spectra of sodium-tellurate glass containing 15 to 22 mole % Na_2O and irradiated at room temperature by ^{60}Co integral gamma doses of 7×10^6 and 1.2×10^7 R. The EPR spectra were studied in an RE-1301 radiospectrometer at 77 and 295°K. It was found that γ radiation produced three paramagnetic centers in the sodium tellurate, with concentrations related to the dose and composition of the glass. (R.V.J.)

44204 EFFECT OF NEUTRON IRRADIATION ON EPR SPECTRA OF ZnS:Ag SINGLE CRYSTALS. Putiev, I. T.; Gavrilov, F. F.; Bezel', V. S.; Pilipenko, G. I.; Chirkov, A. K. (Ural Polytechnic Inst., Sverdlovsk, USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 129-30(1967). (In Russian).

The EPR spectra of ZnS:Ag monocrystals irradiated in a reactor channel by 10^{17} to 10^{18} neutron/cm^2 at ~80°C were studied. Under treatment with infrared light, the amplitude of EPR signals in crystals irradiated with 10^{17} neutron/cm^2 doses was reduced, depending on the irradiation time. Moreover, after reaching a certain magnitude, the amplitude of the signal with g factor 2.0037 remained constant. The effect of temperature on the EPR signal amplitude was studied before and after neutron irradiation. In the case of g factor 2.0003, the signal amplitude decreased with the increased temperature. The amplitude of EPR signal with the g factor 2.0037 was not affected by the temperature. After annealing irradiated crystals in air at 300 to 400°C the colored crystals became transparent, the absorption spectrum was restored, and the signal amplitude with g factor 2.0003 was also restored while the signal with factor 2.0037 disappeared. (R.V.J.)

44205 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED SEMICONDUCTORS. Ursu, I.; Lupei, V.; Nistor, S. V. (Cluj Univ.). At. Energy Rev., 5: 97-138(Apr. 1967).

A review is presented on electron spin resonance (ESR) studies carried out on various types of semiconductors. Short surveys of semiconductors and the ESR method are followed by results obtained with irradiated silicon, germanium, diamond, and compound semiconductors such as zinc sulfide and glasses. (auth)

44206 PAIR DISTRIBUTION FUNCTION OF AN INTERACTING ELECTRON GAS. Geldart, D. J. W. (McGill Univ., Montreal). Can. J. Phys., 45: 3139-61(Sept. 1967).

The pair distribution function, in the limit of zero separation, of an interacting electron gas at high and metallic densities is investigated by many-body perturbation theory. It is shown that the usual methods for maintaining self-consistency in approximate calculations violate, in general, the nonnegativity of the pair distribution function. In particular, the Pauli principle yields a rigorous sum rule for the parallel spin density fluctuation propagator which is not satisfied. Upper and lower bounds on one-loop and multiloop contributions to the pair distribution functions are given. These bounds are used to discuss correlation corrections. An improved wave-number dependence is given for Hubbard's (1957) approximation to the screening function and numerical results are given for a simple class of exchange corrections. (auth)

44207 MOESSBAUER EFFECT DATA INDEX 1958-1965. Muir, Arthur H. Jr.; Ando, Ken J.; Coogan, Helen M. New York, Interscience Publishers, 1966. 366p.

Publications in the field of the Moessbauer effect appearing between 1958 and 1965 are covered, providing three different approaches for locating references of interest: by experiment (isotope and substance investigated), by subject category, and by author and/or co-author. Relevant nuclear properties and decay scheme data are presented for each isotope. Parameters of interest are calculated from these properties. (M.H.K.)

Theoretical Physics

Refer also to abstracts 44337 and 44437.

44208 (BNWL-452) RELATIVISTIC ION IN ELECTROMAGNETIC WAVE (BATTELLE-NORTHWEST PROGRAM ORBIT). Duane, Bernard H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). June 1967. Contract AT-(45-1)-1830. 44p. Dep. CFSTI.

Battelle-Northwest program Orbit constructs and plots eight-dimensional phase-space orbits for a relativistic charged particle driven by an electromagnetic plane wave. (auth)

44209 (N-67-26178) COVARIANT NOETHER IDENTITIES IN COVARIANT FIELD THEORIES. Roy, John R. (Illinois Univ., Urbana. Coordinated Science Lab.). July 1966. 11p. (NASA-CR-84006; R-305). CFSTI.

In covariant field theories such as general relativity the application of Noether's theorem results in a set of identities which are satisfied regardless of whether the field equations are satisfied or not (so-called strong conservation laws). In the conventional formulation these identities contain non-tensorial quantities and nontensorial operations. Thus, for example, the energy-momentum pseudo-tensor of general relativity is obtained from such formulations. The identities arising from Noether's theorem are written in an obviously covariant form containing only tensors and covariant derivatives. As an example these identities for general relativity are given. (auth) (STAR)

44210 (NASA-SP-153, pp 299-308) RELAXATION OF A ONE-DIMENSIONAL SELF-GRAVITATING GAS. Lecar, Myron (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.); Cohen, Leon (Hunter Coll., New York. Smithsonian Astrophysical Observatory, Cambridge, Mass.).

A 1000-sheet model is integrated in an attempt to see if an asymmetric distribution will become symmetric. The velocity distribution is Gaussian with $\langle v^2 \rangle \approx 1$ for all x. (W.D.M.)

44211 UNIQUENESS OF THE ENERGY-MOMENTUM COMPLEX IN THE SPECIAL AND GENERAL RELATIVITY. Bicak, J. (Charles Univ., Prague). Wiss. Z. Friedrich-Schiller-Univ., Jean, Math.-Naturwiss. Reihe, 15: 83-5(1966).

In the special theory of relativity, the most convenient method for deriving the energy-momentum tensor is based on the use of Lagrangian formalism by means of Noether's theorem. In such a way it is possible to obtain the canonical energy-momentum tensor t_{ik}, and by adding the divergence of the superpotential h_{ikl} to obtain the symmetric one $T_{ik} = t_{ik} - h_{ikl,l}$. Due to the antisymmetry of h_{ikl} in the first 2 indices, both tensors give the same total quantities. In general relativity the same method leads to the energy-momentum complex. However, it is not obvious that all energy-momentum tensors (complexes) can be obtained by this procedure. The energy-momentum tensors of wave fields and the energy-momentum complexes of the gravitational field were studied. It was found that Fock's requirements have to be modified, for these fields are described by equations of the second order. For this reason, the role for the energy-momentum tensors as arbitrary functions of their first derivatives was stated. The resultant expressions are now not uniquely determined in all cases, but in most of them it is possible to avoid arbitrariness by supplementing further reasonable conditions (e.g., positive definition of the total energy or the gauge invariance). (BBB)

44212 QUANTUM-RELATIVISTIC CONCEPT OF THE ELECTRON. Sofonea, L. (Polytechnic Inst., Brasov, Rumania). Stud. Cercet. Fiz., 19: 469-540(1967). (In Rumanian).

In order to be able to describe the behavior of high-velocity microparticles involved in high-energy processes, the Broglie wave equation must be brought in agreement with the theory of relativity. For the photon with a zero rest mass, the quantification must be relativistic; it must be applied also for particles with a given rest mass, such as the electron, the proton, or the positron. In order to obtain a variable relativistic equation for any microparticle with a mass m, the relativistic Hamiltonian, or the relation between energy and impulse, must be used. The motion of the electron is well described by Dirac's theory which explains the nature of spin and helps to derive a concept for a hydrogen atom model, by solving the equation for an electron moving within the field created by nucleus. This equation may be applied only to the electron because of the electromagnetic character of the interactions; proton interactions involve meson fields and related nuclear forces. Dirac's theory concerning matter, field, and microparticles allows to derive the model of the spinor field associated with electrons and positrons in the electromagnetic interaction. (Historical review article, 42 references). (TTT)

44213 CHERENKOV RADIATION IN DIELECTRIC MEDIUM WITH CONDUCTIVITY. Khan, R. M. (City Coll., Calcutta). Indian J. Phys., 41: 260-5(Apr. 1967).

Cherenkov radiation through a dielectric medium having conductivity has been considered. It has been shown that Cherenkov radiation is obtained at any velocity of the particle through the medium though the attenuation will be large for low velocities. Some features of penetration length have been discussed which are unlike those of usual electromagnetic radiation in conducting media. The opening angle also seems to be of interest. (auth)

44214 CLASSICAL RADIATION BY AN ELECTRON IN UNIFORM CIRCULAR MOTION IN THE FORM OF MULTIPOLES. Khan, T. P. (D. A. Coll., West Bengal, India). Indian J. Phys., 41: 305-8(Apr. 1967).

An attempt has been made to obtain classical radiation by an electron in uniform circular motion in the form of multipoles. An electric charge within a medium of dielectric constant ϵ is moving in a circular orbit with constant angular velocity. The motion is assumed to be confined in a plane and the angular distribution of the radiation have been obtained after integration of the usual energy term on the surface of a sphere. The spherical wave solution of Maxwell's equation, the multipole expansion of the electromagnetic fields, and the angular distribution of multipole radiation are calculated. (M.H.R.)

44215 CHERENKOV RADIATION IN A SEMI-INFINITE DIELECTRIC MEDIUM WITH A CONDUCTING BOUNDARY. Khan, R. M. (City Coll., Calcutta). Indian J. Phys., 41: 270-4(Apr. 1967).

Cherenkov radiation due to the passage of a point charge moving parallel to the conducting boundary inside a semi-infinite dielectric medium has been studied. The formulae obtained are in agreement with the formulae for Cherenkov radiation for electrons in an infinite homogeneous medium in the limiting case. (auth)

44216 CONFORMAL-GALILEAN SPACE (FRIEDMAN-LOBACHEVSKII SPACE). Kurdgelaidze, D. F. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 24-34(Jan.-Feb. 1967). (In Russian).

Einstein equations in the Friedman-Lobachevskii space were investigated. The equation of state was constructed for the generalized case and for the case with $p = 0$ and $p = \rho/3$; closed analytical solutions were found for $p = \rho$. The solutions obtained for $\lambda \approx -\lambda$ conversions were analyzed and it is shown that the solutions for the conversion $\lambda \approx -\lambda$ can be expanded to describe the expansion-contraction transition. (tr-auth)

44217 ON A REPRESENTATION IN QUANTUM OPTICS. Bergmann, S. M. (Oxford Univ.). Proc. Phys. Soc. (London), 91: 804-6(Aug. 1967).

A dynamical problem in quantum optics is that of solving Schrödinger's equation with the initial state of the radiation field as a coherent state. By carrying out a particular unitary transformation it is shown how a representation of the radiation field operators can be arrived at which is particularly convenient for processes in which the interaction with the material system only involves one photon or a few photons. It is shown in which sense this representation is a counterpart of the Fock representation. In the derivation of the representation, which is exact throughout, some features are brought out which may be interpreted as being semiclassical. (auth) (UK)

44218 NOTE ON CLASSICAL FIELDS OF HIGHER ORDER. Thielheim, K. O. (Univ., Kiel). Proc. Phys. Soc. (London), 91: 798-803(Aug. 1967).

The Lagrangian density of a classical field is considered, which depends on the partial derivatives of the field components up to the Nth order. Explicit expressions for the density of energy, momentum, and angular momentum are obtained from Noether's theorem. A Hamilton formalism for this kind of field is presented. (auth) (UK)

44219 FIELD OF A POINT CHARGE IN A GYROTROPIC DIELECTRIC. Mergelyan, O. S. Zh. Tekh. Fiz., 37: 827-32 (May 1967). (In Russian).

The field and the Cherenkov radiation of a point charge moving with uniform velocity along the axis of a gyrotropic dielectric are calculated. (TSS)

44220 RADIATION OF A CHARGED PARTICLE MOVING ON A HELICAL PATH THROUGH THE PLANE SEPARATING TWO DIELECTRICS. Angeleiko, V. V.; Kitsenko, A. B. (Kharkov State Univ.). Zh. Tekh. Fiz., 37: 836-50(May 1967). (In Russian).

The cyclotron, Cherenkov, and transition radiations are calculated for a charged particle moving on a helical path whose axis, which is in the direction of a uniform external magnetic

field, is perpendicular to the plane separating two semi-infinite isotropic dielectrics. The calculations are performed in detail with the aid of a Laplace transformation in the spatial coordinate parallel to the axis of the trajectory and Fourier transformations in the time and the remaining two spatial coordinates, and some features of the solutions are presented graphically. There are calculated the angular and frequency ranges within which each of the components of the radiation is observed, as well as the spectral density of each radiation component. The results reduce in appropriate limiting cases to known formulas for the cyclotron and Cherenkov radiation of a particle moving on a helical path in an infinite homogeneous dielectric and the Cherenkov and transition radiation of a particle moving on a straight line perpendicular to the plane boundary between two semi-infinite dielectrics. (ATD)

44221 BOUND STATES OF AN ELECTRON IN A POINT ELECTRIC-DIPOLE FIELD: QUANTIZATION OF A CLASSICAL SOLUTION. **Fox, K. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Phys. Lett., 25A: 345-6(Sept. 11, 1967). (ORNL-P-3305).**

The condition for bound classical motion of an electron in a point electric-dipole field is shown to be $D > 3\sqrt{3}\, p_\phi^2/4m_e e$, and the quantization of the component p_ϕ of angular momentum leads to previously calculated minimum values of dipole moment D required for binding in the quantum mechanical motion about a finite or point dipole. (auth)

44222 CHARACTERISTIC HYPERSURFACES IN GENERAL RELATIVITY. I. **Dautcourt, G. (Inst. of Pure Mathematics, Berlin). J. Math. Phys. (N. Y.), 8: 1492-1501(July 1967).**

Lightlike (null) hypersurfaces are treated by means of an intrinsic Ricci rotation coefficient technique. This provides an effective way of dealing with the various types of geometry on a null hypersurface. The formalism is used to examine inner affinities, differential invariants, local features such as asymptotic and shear directions and geodesic lines, and to give a short description of null hypersurfaces in flat space-time. Applications to gravitational radiation theory and cosmology are briefly mentioned. (auth)

44223 RADIATION OF POLARIZED ELECTRONS HAVING LOW ENERGY LEVELS IN A MAGNETIC FIELD. **Bagrov, V. G.; Dorofeev, O. F. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 2, 97-101(Mar.-Apr. 1966). (In Russian).**

Quantum theory methods are used to analyze the radiation of electrons with oriented spin, moving in a magnetic field and having low energy levels. Comparison of the expressions for the intensity of radiation of a relativistic electron moving in a constant and homogeneous magnetic field, obtained in classical theory and with allowance for quantum corrections, shows that quantum effects begin to play a noticeable role at high electron energies, when the electron quantum number (n) of the electron is large and the spectrum is quasicontinuous. It is shown that at small values of n, the discreteness of the energy spectrum can greatly influence the radiation intensity. In that case, and for longitudinal polarization of the electron spin, the electron is shown to radiate only approximately half what classical theory calls for. Furthermore, unlike classical theory, a longitudinally polarized electron radiates light which is circularly polarized. In the case of transverse polarization, the radiation of an electron with spin oriented opposite the field agrees with the classical value, but spin flip again leads to a difference between the classical and quantum values. The smaller the principal quantum number, the greater the deviation between classical and quantum theories. (ATD)

44224 LOCAL ENERGY OF WEAK GRAVITATION WAVES. **Khiet, Vu Tkhan. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 2, 52-9(Mar.-Apr. 1966). (In Russian).**

It is noted that the Christoffel symbol concept gravitation field cannot be localized whereas the Riemannian curvature tensor concept admits localization. The concept is that of Rylov's relative gravitation field (Ann. Phys., 7: 329-53(1964))—permitting localization at all points relative to a base point. Local energy of flat waves, local energy of weak fields in a mass-free space, and local energy of cylindrical waves are investigated. It is shown that for these weak fields the local energy is positive. (ATD)

44225 EINSTEIN'S SPACES ADMITTING GRAVITATIONAL WAVES. **Zakharov, V. D. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 2, 3-8(Mar.-Apr. 1966). (In Russian).**

Studies were made of a new general covariant criterion of gravitational waves as applied to Petrov's gravitational fields according to the algebraic structure of the curvature tensor. It is shown that nontrivial Einstein space, satisfying the criterion, can belong to the confluent type II in Petrov's classification. An inverse theorem is formulated. (tr-auth)

44226 IS IT POSSIBLE FOR ANTIMATTER METEOR TO REACH THE SURFACE OF THE EARTH? **Subotowicz, Mieczyslaw (Maria Curie-Sklodowskiej Univ., Lublin). Postepy Fiz., 18: 465-4(1967). (In Polish).**

The possibility of antimatter meteor reaching the surface of the earth is discussed. (auth)

44227 FRESNEL'S EQUATION IN GENERAL RELATIVITY. **Kremer, Hugo F. (Univ. Federal do Parana, Brazil). J. Math. Phys. (N. Y.), 8: 1197-9(June 1967).**

The Fresnel equation is derived in general relativity using the classical method applied by Levi-Civita in the study of a non-relativistic theory of electromagnetic induction. For the description of the anisotropic medium the theory proposed by Quan is adopted. The study of the Cauchy problem is also presented and the convergence of results assures that the equation proposed is the good one. (auth)

44228 REMARKS ON RELATIVISTIC STATISTICAL MECHANICS. I. **Hakim, Remi (Faculte des Sciences, Orsay, France). J. Math. Phys. (N. Y.), 8: 1315-44(June 1967).**

The modifications introduced by the specific forms of relativistic dynamics of many-particle systems are shown to give rise to a different (with respect to the nonrelativistic case) manner to set the problems involved in a tentative construction of relativistic statistical mechanics. Although the difficult problems of relativistic dynamics are not solved, it is possible to define relativistic generalizations of phase space, distribution functions, Gibbs ensembles, and average values. In particular, phase space is chosen for convenience and is no longer related (as is usually the case) to the "initial data," whose nature is yet unknown. As a consequence, only those observables which depend on the variables characterizing phase space give rise to easily computed average values. However, it is possible to enlarge at will the basic phase space and to define subsequent densities from which average values may be calculated. The notion of equilibrium is discussed and suggestions for reaching the solution of this unsolved problem are made. (auth)

44229 BASIC ALGEBRA OF ANTILINEAR OPERATORS AND SOME APPLICATIONS. I. **Herbut, Fedor; Vujicic, Milan (Inst. of Nuclear Sciences Boris Kidrich, Belgrade). J. Math. Phys. (N. Y.), 8: 1345-54(June 1967).**

An attempt is made to find the canonical (i.e., simplest) form of antilinear operators which is the analog of the diagonal form of linear ones, as well as to obtain that class of antilinear operators which corresponds to the class of normal, i.e., diagonalizable, linear ones. To achieve this aim two basic tools are used: polar factorization of an arbitrary antilinear operator in a linear, Hermitian, positive, semidefinite, and anti-unitary operator $\hat{A}_a = \hat{H}_1\hat{U}_a = \hat{U}_a\hat{H}_2$, and representation of antilinear operators by antilinear matrices, which are products of a matrix factor transforming by unitary congruence transformations and the operation of conjugation which is the same for all antilinear operators and all bases. The canonical form is defined as the simplest form of the matrix factor. The criteria of simplicity are: a quasi-diagonal form with smallest possible submatrices, a maximal number of zeros in them, and as many positive numbers as possible among the nonzero elements. It is found that the analog of the diagonal form of linear operators is the second-order canonical form consisting of a diagonal part with nonnegative elements, which is as large as possible, and of two-by-two submatrices with zeros on the diagonal and with at least one positive element. The operators having this form are those whose polar factors can be simultaneously canonical, taking for the anti-unitary factor, essentially the Wigner canonical form. These antilinear operators are called normal ones, and they can also be defined by the following relations between the polar factors: $[\hat{H}_1, \hat{H}_2] = 0$ and $[\hat{H}_1, \hat{U}_a^2] = 0$ or by the single commutator, $[\hat{A}_a, (\hat{A}_a)^2]_- = 0$. A simple procedure to obtain the canonical form of a given normal antilinear operator is developed. A few applications of the results obtained are outlined. They belong to different fields such as electric network theory, quantum mechanics, and self-consistent Hartree-Bogolyubov theory. (auth)

44230 APPROACH TO GRAVITATIONAL RADIATION SCATTERING. **Torrence, R. J. (Syracuse Univ., N. Y.); Janis, A. I. J. Math. Phys. (N. Y.), 8: 1355-66(July 1967).**

A method is presented for studying asymptotically flat spaces possessing both incoming and outgoing gravitational radiation at infinity. The method uses multipole expansions and the invariance of general relativity under time reversal; calculations are facilitated by a small-parameter perturbation approach. Some calculations are carried out to second order to show the practicability of the method. (auth)

44231 NULL ELECTROMAGNETIC FIELD IN THE FORM OF SPHERICAL RADIATION. Bartrum, Peter C. J. Math Phys. (N. Y.), 8: 1464-7(July 1967).

An example is given of a differential form which leads, through Einstein's gravitational equations, to an energy tensor representing a null electromagnetic field in the form of spherical radiation. (auth)

44232 NOTE ON THE KERR METRIC AND ROTATING MASSES. Cohen, Jeffrey M. (Yale Univ., New Haven). J. Math. Phys. (N. Y.), 8: 1477-8(July 1967).

Kerr's metric is often said to describe the geometry exterior to a body whose mass and rotation are measured by Kerr's parameters m and a, respectively, even though no interior solution is known. An interior solution is given valid in the limit when the rotation parameter a is sufficiently small so that terms of higher power than the first are negligible, but the mass parameter m is allowed to be large. This is accomplished by bringing Kerr's exterior metric into the form of the metric for a slowly rotating mass shell. Also, the connection is found between Kerr's parameters and the physical parameters characterizing the rotating body. (auth)

44233 INVARIANT FORM OF THE CONSERVATION LAWS. Gutman, I. I. (Odessa Polytechnic Inst.). Zh. Eksp. Teor. Fiz., 53: 565-9(Aug. 1967). (In Russian).

An invariant expression for the energy density and a covariant Umov–Pointing vector are introduced which can be employed in an invariant formulation of the integral law of conservation of energy. In the case of the special theory of relativity in inertial reference systems the invariant formulation is identical with the usual one. The invariant expression for the integral energy flux is specified for the case of the general theory of relativity. An invariant hamiltonian is set up for a system of point masses in a gravitational field. (auth)

44234 AN EXACT STATIC AXIAL SOLUTION OF THE EINSTEIN EQUATIONS. Stepanyuk, N. M. (Ukrainian Agricultural Academy, Kiev). Zh. Eksp. Teor. Fiz., 53: 570-2(Aug. 1967). (In Russian).

An exact solution of the equations of general relativity theory is presented for the special case of static axial symmetry of the gravitational field. Its relation to the well known Schwarzschild–Einstein–de Sitter solutions is demonstrated. Expressions are given for the self pressure p_0 and density ρ_{00} and for the dependence of Gaussian curvature on p_0 and ρ_{00}. (auth)

44235 STATIC SCALAR AND ELECTRIC FIELDS IN EINSTEIN'S THEORY OF RELATIVITY. Asanov, R. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 673-9(Aug. 1967). (In Russian).

A model of a spherically symmetric body (sphere) in the presence of gravitational, electromagnetic, and scalar fields is considered. Static solutions are found which differ from the solutions obtained by Fisher, Bergman and Leipnik in that, contrary to the latter solutions, the present ones satisfy the general requirements imposed on static solutions in general relativity theory and thus can be naturally interpreted physically. (auth)

44236 OSCILLATIONS OF COMPRESSIBLE CYLINDERS. Robe, H. (Univ. de Liege, Cointe-Sclessin, Belg.). Ann. Astrophys., 30: 605-16(July-Aug. 1967). (In French).

The oscillations of the polytropic and compressible cylinders are investigated by the method of small perturbations. The radial and nonradial modes exhibit a pattern similar to those of the polytropic spheres. The gravitational instability manifests itself as a separate mode when the cylinder is convectively stable (A everywhere negative) and enhances the instability of the gravitational modes when A is positive. (auth)

44237 "INVERSE" TERRELL EFFECT. Guess, A. W. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Phys. Rev., 161: 1295-1300(Sept. 25, 1967).

Terrell has shown that when an observer takes an instantaneous photograph of a rapidly moving object, the photograph shows the object to be rotated (through the aberration angle) to show more of its trailing side than would a photograph of the object brought to rest at the same apparent position. The object subtends a small solid angle to the observer and continuously emits light. The inverse situation is considered where an observer takes a long-exposure photograph of a rapidly moving object which, in its own coordinate system, emits an instantaneous "pulse" of light simultaneously over its entire surface. Again the object subtends a small solid angle to the observer, but it now makes a difference whether or not the observer follows or tracks the motion of the object. It is found that when the observer follows the object with his camera, the long-exposure photograph shows the object to be undistorted, but rotated (through the aberration angle) to show more of the trailing side of the object, compared with a photograph of the object brought to rest at the same apparent position (similar to Terrell's result). When the observer does not track the object with his camera, the long-exposure photograph shows the object to be unrotated, but apparently "Lorentz-lengthened" by the factor $(1-v^2/c^2)^{-1/2}$ (v = velocity of object, c = velocity of light) in the direction of the object's motion. (auth)

44238 FIVE-DIMENSIONAL RELATIVISTIC SCHEME. II. Pyt'ev, Iu. P. (Univ., Moscow). Vestn. Moskov. Univ., Ser. III, Fiz. Astron., 21: 70-80(Sept.-Oct. 1966). (In Russian).

Continuation of a study of five-dimensional relativistic space, discussing the general case of the five-dimensional Riemannian space having the metric form $-d\sigma^2 = G_{\alpha\beta}dx^\alpha dx^\beta$. A physical interpretation of this space is given. (IAA)

44239 CONSTRUCTION OF RARITA–SCHWINGER FIELDS AND INTERACTION LAGRANGIANS FOR FIELDS WITH ARBITRARY SPIN. Wilson, William A. (Univ. of Florida, Gainesville). Can. J. Phys., 45: 3129-38(Sept. 1967).

The formal connection between Rarita–Schwinger fields and fields which have no subsidiary conditions is made, using the Lorentz transformation properties of the fields. By employing this formal connection, the most general interaction Lagrangians, which couple fields with arbitrary spin, are constructed. (auth)

44240 CERTAIN PROBLEMS OF CLASSICAL THEORY OF RADIATION. Bagrov, V. G.; Markin, Yu. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 37-42(1967). (In Russian).

Precise equations were obtained for the radiation energy losses by a charged particle in motion in electric and magnetic fields and in plane wave fields. Polarization of instantaneous radiation from an arbitrary moving charge was also resolved. Both problems are resolved within the limits of classical theory. (tr-auth)

44241 SCATTERING OF ELECTRONS MOVING IN MAGNETIC FIELD. Ternov, I. M.; Dorofeev, O. F. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 81-8 (1967). (In Russian).

The problem of relativistic electron scattering by spherically symmetric energy centers is analyzed. It is assumed that electrons are in motion in a constant and homogeneous magnetic field. (tr-auth)

44242 CONFORMAL THEORY OF GRAVITATION. Islam, Jamal N. (Univ. of Cambridge, Eng.). Proc. Cambridge Phil. Soc., 63: 809-17(July 1967).

Recently Hoyle and Narlikar put forward a conformal theory of gravitation in which they obtained an explicit solution of the field equations using certain approximations and assumptions of symmetry. To obtain the solution, the metric is assumed to have a special form. A more general form of the metric is considered, and it is shown that many of the features of the special solution are shared by the solution in the more general case. In particular, the implications of the special solution as concerns the sign of the gravitational constant remain valid in the more general case under certain assumptions. (auth) (UK)

44243 QUANTIZATION IN CLIFFORD SPACE–TIME AND PROBLEMS IN GROUP THEORY. PARTS I AND II. Wenger, Daniel Lee. Los Angeles, Univ. of California, 1966. 128p. Thesis.

Certain problems of quantization in a space–time which has the properties of zero curvature and uniform torsion and which approaches Minkowski space as the torsion vanishes are discussed. Specifically, the solutions to the Klein–Gordon equation and the Dirac equation in this space are found. A special property of these solutions is that they are normalizable. The space–time in question is shown to be compatible with a cosmological model based on Einstein's equations where the energy-momentum tensor is that of the ground state of a system of fermions. An axial vector-axial vector interaction between the fermions is assumed and the ground state is discussed in terms of the Schafroth condensation of fermion pairs. In this aspect, the model is similar to one discussed by Nambu. The integral equation for the energy gap turns out to be solvable due to the fact that the kernel is separable. Various modifications of the interaction are considered which allow the energy gap to be computed. The study of SU_n is extended to include the determination of particular root vectors and fundamental weights. The root vectors are chosen so as to show explicitly the canonical nesting of subgroups $SU_n \supset SU_{n-1} \times U_1$, $SU_{n-1} \supset SU_{n-2} \times U_1$, etc. Explicit matrix representations of the fundamental representations are given. The results are all de-

pendent upon the use of n vectors which define the fundamental region of SU_n. Eigenvalues of fundamental invariant operators are also given in terms of these n vectors. A simple method is discussed for finding a closed form expression for finite matrix transformations when the infinitesimal generator is given. The result is given in terms of the diagonalized elements of the generator, i.e., in terms of the Weyl parameters, and in terms of finite powers of the generator. (Disser. Abstr.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 43233.

44244 HIGH ENERGY PHOTOPRODUCTION OF NEUTRAL RHO MESONS ON COMPLEX NUCLEI. Asbury, J. G. (Deutsches Elektronen-Synchrotron, Hamburg); Becker, U.; Bertram, William K.; Joos, P.; Rohde, M.; Smith, A. J. S.; Jordan, C. L.; Ting, Samuel C. C. Phys. Rev. Lett., 19: 865-8(Oct. 9, 1967).

Photon reactions at peak incident bremsstrahlung energies of 4.35 and 6.02 GeV with beryllium, carbon, aluminum, copper, silver, and lead were studied for the production of $\pi^+\pi^-$ pairs at forward angles. The objects of the experiment were to search for possible 0^+, 1^-, 2^+, ... resonances by measuring the pair invariant mass distribution in the region 0.35 to 1.2 GeV/c^2, to study the mechanism by which mesons (ρ^0) are produced at high energy and low momentum transfers, where diffraction seems to dominate, to determine the ρ^0 cross section using the diffraction model, and to determine the mass and width of photoproduced mesons (ρ^0). (J.F.P.)

44245 LEPTONIC DECAYS OF VECTOR MESONS: THE BRANCHING RATIO OF THE ELECTRON–POSITRON DECAY MODE OF THE RHO MESON. Asbury, J. G. (Deutsches Elektronen-Synchrotron, Hamburg); Becker, U.; Bertram, William K.; Joos, P.; Rohde, M.; Smith, A. J. S.; Jordan, C. L.; Ting, Samuel C. C. Phys. Rev. Lett., 19: 869-72(Oct. 9, 1967).

A measurement of the branching ratio $\Gamma(\rho^0 \to e^+ + e^-)/(\rho^0 \to \pi^+ + \pi^-)$, from which the coupling constant $g_{\gamma\rho}$ may be obtained directly is reported. To obtain this branching ratio, the reactions $\gamma + C \to C + \rho^0$, $\rho^0 \to e^+ + e^-$ and $\rho^0 \to \pi^+ + \pi^-$ were measured below 6.02 GeV using a symmetric double-arm magnetic spectrometer. (J.F.P.)

44246 TEST FOR TIME-REVERSAL INVARIANCE OF THE ELECTROMAGNETIC INTERACTION USING THE MOESSBAUER EFFECT IN ^{99}Ru. Kistner, O. C. (Brookhaven National Lab., Ill.). Phys. Rev. Lett., 19: 872-7(Oct. 9, 1967). (BNL–11632).

The Mössbauer effect on the 90-keV M1 – E2 mixed transition in ^{99}Ru is used to measure the time reversal invariance of the electromagnetic interaction. This measurement is an order of magnitude more sensitive than previous attempts. It was found that there is no violation of T invariance. (J.F.P.)

44247 PHOTOPRODUCTION OF ANTINEUTRONS AND ANTIPROTONS FOR PHOTON ENERGY BETWEEN 4.0 AND 5.7 BeV. Earles, D.; Gettner, M.; Glass, G.; Laohavanich, Y.; von Goeler, E.; Weinstein, Roy (Northeastern Univ., Boston). Phys. Rev. Lett., 19: 922-5(Oct. 16, 1967).

A search was made for the $\gamma + p \to \bar{n} + d$ interaction from bremsstrahlung interactions with a liquid-hydrogen target at 4.2 to 5.7 BeV lab energies. Details of the time-of-flight spectra are presented. An upper limit of $d\sigma/d\Omega < 1.2 \times 10^{-33}$ cm^2/sr was obtained after applying corrections. Results are also reported on a preliminary search for antiprotons photo-produced in hydrogen, carbon, and copper. (L.B.S.)

44248 SIXTH-ORDER RADIATIVE CORRECTIONS TO THE MUON MAGNETIC MOMENT. Kinoshita, T. (CERN, Geneva). Nuovo Cim. (10), 51B: 140-98(Sept. 11, 1967).

It is shown that the α^3 corrections to $\frac{1}{2}(g_\mu - g_e)$ can be expressed in the form $(\alpha/\pi)^3[\frac{2}{9}(\ln(m_\mu/m_e))^2 - 1.114\ln(m_\mu/m_e) + 1.344 + C]$, where g_μ and g_e are the g factors of muon and electron, respectively, and C is a constant independent of the electron mass m_e yet to be calculated. This formula is derived by simple algebraic manipulations from the second- and fourth-order results of g_e and Z_3 (charge renormalization constant). The result shows that the α^3 corrections to $\frac{1}{2}(g_\mu - g_e)$ will not be much larger than $2 \cdot 10^{-6}$, and thus will not seriously affect the experimental determination of the α^2 corrections. Furthermore it will provide a consistency check for any future calculation of the complete α^3 corrections to the muon magnetic moment. (auth)

44249 INVESTIGATION OF THE ANGULAR DEPENDENCE OF THE CROSS SECTION FOR PHOTOPRODUCTION OF CHARGED PIONS ON NUCLEONS. Adamovich, M. I.; Larionova, V. G.; Latypova, R. A.; Lebedev, A. I.; Kharlamov, S. P.; Yagudina, F. R. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 53: 528-38(Aug. 1967). (In Russian).

The differential cross sections for the $\gamma + p \to n + \pi^+$ process are measured by γ-quanta energies of 200, 205 and 240 MeV and meson emission angles of 16, 24, 36, 44, 56, 64, 76, 84, 96, 104, 116, 124, 136, 144 and 156° with respect to the photon beam in the laboratory system. A phenomenological analysis of the results is carried out and some multipole charged meson photoproduction amplitudes are determined. The results are compared with the predictions of the dispersion relations theory. (auth)

44250 QUASIELASTIC ELECTRON–DEUTERON SCATTERING AT FORWARD ANGLES. Budnitz, R.; Appel, J.; Carroll, L.; (and others). (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 19: 809-12(Oct. 2, 1967).

A preliminary report of measurements of quasielastic electron–deuteron scattering is presented. Data points were taken at a scattered electron laboratory angle of 20° and for a range of four-momentum transfers from 7 to 70 F^{-2}. Three measured quantities were extracted from the data. These are the ratio of electrons without a coincident proton to electrons with a coincidence which after small corrections should equal the neutron–proton cross section ratio, the ratio of the total electron–deuteron area-method quasielastic cross section to the elastic e–p cross section from hydrogen, and the ratio of the electron–proton coincidence cross section from deuterium to the same e–p coincidence cross section from hydrogen using the area method. (J.F.P.)

44251 PHOTOPRODUCTION OF WIDE-ANGLE ELECTRON–POSITRON PAIRS AT HIGH ENERGIES. Asbury, J. G. (DESY, Hamburg); Bertram, William K.; Becker, U.; Joos, P.; Rohde, M.; Smith, A. J. S.; Friedlander, S.; Jordan, C. L.; Ting, Samuel C. C. Phys. Rev., 161: 1344-55(Sept. 25, 1967).

Using the DESY 6.2-GeV electron synchrotron, the photoproduction on carbon of electron-positron pairs was measured for a range in the invariant pair mass of 150-550 MeV. To detect the pairs and to discriminate against the intense pion background, a magnetic spectrometer, counters, and fast electronics were used. The results are in agreement with the predictions of first-order quantum electrodynamics, in contradiction with earlier experiments. A comparison of the results with other tests of quantum electrodynamics at small distances is discussed. (auth)

44252 POSITIVE PION PHOTOPRODUCTION FROM HYDROGEN AT LARGE ANGLES IN THE REGION OF THE FIRST RESONANCE. Aleksandrov, Yu. M.; Grushin, V. F.; Leikin, E. M. (Lebedev Inst. of Physics, Moscow). Phys. Lett., 25B: 372-5 (Sept. 18, 1967).

The results of measurement of differential cross sections for the process $\gamma p \to n\pi^+$ are presented for γ-ray energies 260, 290, 320 MeV and pion angles 90° to 180°. (auth)

44253 EXPERIMENTAL DETERMINATION OF THE η LIFETIME BY THE MEASUREMENT OF THE PRIMAKOFF EFFECT. Bemporad, C. (Univ., Pisa, Italy. Istituto Nazionale di Fisica Nucleare, Pisa, Italy); Braccini, P. L.; Foa, L.; Luebelsmeyer, K.; Schmitz, D. Phys. Lett., 25B: 380-4(Sept. 18, 1967).

An experiment for determining the η lifetime was performed at DESY. The cross section for η photoproduction was measured between 0 and 4°, at 4.0 GeV and 5.5 GeV incident γ ray energies and on different target materials (lead, silver, zinc). η's were detected through their γ-γ decays. The production is dominated by the Primakoff effect from which a value of $\Gamma_{\gamma\gamma} = (1.21 \pm 0.26)$ keV is derived. (auth)

Weak

Refer also to abstract 44287.

44254 (AD–657984) LEPTONIC TRIPLETS. Kursunoglu, Behram (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies). Aug. 1967. 10p. (CTS-HE–67-5). CFSTI.

A neutral lepton e_0 of mass $m_0 = 1.00486\ m_e$ and an associated third neutrino ν_0 were predicted from a recent theory of baryons and leptons. The decays $K_2^0 \to \pi^0 + \bar{\nu}_0 + e^0$ ($\pi^0 \to \gamma + \nu_0$), $K_2^0 \to \bar{\nu}_0 + e^0$ ($\bar{\nu}_0 \to \gamma + \nu^0$) etc., are discussed for a possible experimental search of these particles. (auth)

44255 (UCRL-17740) MEASUREMENT OF THE ELECTRON-ASYMMETRY PARAMETER OF $\Sigma^- \to n + e^- + \bar{\nu}$. Gershwin, Lawrence K.; Alston-Garnjost, Margaret; Bangerter, Roger O.; (and others). (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 14, 1967. Contract W-7405-eng-48. 11p. (CONF-670934-2). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

The up-down asymmetry of electrons from the decay $\Sigma^- \rightarrow n + e^- + \bar{\nu}$ is examined using polarized Σ^-'s produced via the reaction $K^- + p \rightarrow \Sigma^- + \pi^+$ at 400 MeV/c. This leads to a g_A/g_V which somewhat favors the solution B of Willis et al. (Phys. Rev. Letters 13: 291(1964)). (J.F.P.)

44256 (UCSD-10P10-102) INTERFERENCE EFFECTS OF NEUTRAL KAONS AND SIGN OF THEIR MASS DIFFERENCE. Mehlhop, W. A. W.; Good, R. H.; Piccioni, O.; Swanson, R. A.; Murty, S. S.; Burnett, T. H.; Holland, C. H.; Bowles, P. (California Univ., La Jolla, San Diego). July 1966. Contract AT(11-1)-Gen-10. 12p. (CONF-660808-25). Dep. CFSTI.

From 13th International Conference on High Energy Physics, Berkeley, Calif.

A pure K^0 beam is produced at time zero by charge exchange of a K^+ beam. At a later time the beam passes through a regenerator. At the exit of the regenerator, the beam contains a directly produced K_S and a K_L-regenerated K_S wave. The phase of these two waves depends on the distance from the source to the regenerator, multiplied by the mass difference $m_L - m_S$. By varying this distance, the interference of the two waves was studied. It was found that the two waves decay into quantum mechanically identical states, that the magnitude of the mass difference is 0.44 ± 0.06, and that K_L is heavier than K_S. (J.F.P.)

44257 ASYMMETRY OF POSITRONS FROM THE DECAY $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ IN THE LONGITUDINAL 140000 Oe MAGNETIC FIELD. Akhmanov, V. V.; Gurevich, I. I.; Dobretsov, Yu. P.; Makar'ina, L. A.; Mishakova, A. P.; Nikol'skii, B. A.; Sokolov, B. V.; Surkova, L. V.; Shestakov, V. D. Yadern. Fiz., 6: 316-28(Aug. 1967). (In Russian).

The energy integrated angular distribution of positrons from the decay $\pi^+ \rightarrow \mu^+ \rightarrow e^+$ proceeding in photoemulsion in the longitudinal (along direction of the μ-meson spin) 140,000 Oe magnetic field was measured. The total number of the measured events is 190,000. The experimental angular distribution of positrons has the form $1 - a \cos\theta$ where $a = 0.325 \pm 0.005$. This result agrees with the theory of the universal V−A-interaction. (auth)

44258 MEASUREMENT OF ANGULAR $e\nu$-CORRELATION AT FREE NEUTRON DECAY. Grigor'ev, V. K.; Grishin, A. P.; Vladimirskii, V. V.; Nikolaevskii, E. S.; Zharkov, D. P. Yadern. Fiz., 6: 329-35(Aug. 1967). (In Russian).

From energetic spectrum of recoil protons the angular correlation between the electron and neutrino in the β-decay of free neutron was determined. It was found that the angular correlation constant is $\lambda = -0.091 \pm 0.039$. From these data the ratio between the constants $|G_A|$ and $|G_V|$ which proved to be 1.22 ± 0.08 was calculated. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 44421 and 44555.

44259 (BNL-11715) PRODUCTION OF HIGH-MOMENTUM DEUTERONS FROM NUCLEI BOMBARDED BY 1 GeV PROTONS. Friedes, J. L.; Sutter, R.; Palevsky, H.; Bennett, G. (Brookhaven National Lab., Upton, N. Y.); Igo, G. J. (Los Alamos Scientific Lab., N. Mex.); Simpson, W. D.; Phillips, G. C. (Rice Univ., Houston, Tex.); Corley, D. M.; Wall, N. S. (Maryland Univ., College Park); Stearns, R. L. (Vassar Coll., Poughkeepsie, N. Y.). Aug. 30, 1967. 11p. (CONF-670910-2). Dep. CFSTI.

From International Conference on Nuclear Structure, Tokyo, Japan.

Previous measurements of high-momentum deuterons produced from the bombardment of nuclei by 1-GeV protons are extended to helium-4, lithium-6, carbon-12, oxygen-16, and natural lead at forward deuteron angles of 5, 10, and 15°. All the results are consistent with the reaction $p + (A,Z) \rightarrow d + p + (A-2, Z-1)$. (J.F.P.)

44260 (INR-802/VI/PH) AN ATTEMPT OF DETERMINATION OF PROTON-NUCLEON ELASTIC CROSS SECTION IN TeV REGION. Rybicki, K. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 5p. Dep.

There were 5.82 m of ultra-high-energy-proton (E > 1 TeV) track line-scanned for stars resulting from elastic scatterings on nucleons bound in emulsion nuclei. Three events of this type were found. In order to find the probability of visible evaporation of the nucleus in such process a similar scanning was performed on 24-GeV proton tracks. The proton-nucleon elastic cross section $\sigma_{el} = (3.8^{+1.2}_{-1.1})$ mb was obtained in the TeV region. (auth)

44261 (IS-1651) INVESTIGATION OF KINEMATIC FITTING RESULTS FOR BUBBLE CHAMBER EVENTS INVOLVING NEUTRAL PARTICLES AT HIGH ENERGIES. Kernan, W. J.; Schalk, T. L.; Schroeder, L. S.; Wagstaff, R. L. (Ames Lab., Iowa). Mar. 1, 1967. Contract W-7405-eng-82. 33p. Dep. CFSTI.

A study of the reliability of one-constraint kinematic fits to bubble chamber events involving unobserved neutrons or pions was carried out for high momentum incident particles. The study used events known to be $PP \rightarrow PP\pi^+\pi^-$ at an incident proton momentum of 22 GeV/c. It is shown that a special group of one-constraint events involving high-momentum neutrons can be clearly separated from the background reactions. No general applicability of the results is claimed but the method used is generally applicable. (auth)

44262 HIGH-ENERGY, SMALL-ANGLE, p−p AND $\bar{p}$−p SCATTERING, AND p−p TOTAL CROSS SECTIONS. Foley, K. J.; Jones, R. S.; Lindenbaum, S. J.; Love, W. A.; Ozaki, S.; Platner, E. D.; Quarles, C. A.; Willen, E. H. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett., 19: 857-9(Oct. 9, 1967). (BNL-11776).

Small-angle p + p differential elastic scattering cross sections from 8 to 26 GeV/c and $\bar{p}$ + p cross sections at 12 GeV/c were measured, and the real part of the nuclear amplitude was deduced from Coulomb−nuclear interference under the assumption of spin independence. Also the p + p total cross section from 8 to 26 Gev/c was measured with errors of 0.3%. (J.F.P.)

44263 ESTIMATION OF THE ENERGY OF THE PRIMARY AND C.M.S. VELOCITY OF JETS BY VARIOUS METHODS. Kamal, A. A.; Rao, G. K. (Osmania Univ., Hyderabad, India). Proc. Indian Acad. Sci., Sect. A, 66: 15-32(July 1967).

The relative merits of three methods the median angle method, the Castagnoli method, and the Yajima-Hasegawa method, for the estimation of the energy of the primary are examined. The correction factors for the breakdown of the conditions of velocity independent spectrum and symmetry of jets are obtained. (auth)

44264 INVESTIGATION OF THE ELASTIC pd-SCATTERING AT LARGE ANGLES IN THE ENERGY REGION 0.75 TO 2 GeV. Birger, N. G.; Borisov, V. S.; Bysheva, G. K.; Gol'din, L. L.; Kondrat'ev, L. N.; Korotkov, M. M.; Martusov, E. T.; Sidorenko, Z. S.; Sokolov, L. I.; Tumanov, G. K. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 344-8(Aug. 1967). (In Russian).

The techniques are described and the results are given for measurements of the backward elastic pd-scattering cross sections at the angle $\theta = 13°$ at the incident proton energies 0.75, 1.0, 1.65, and 2.0 GeV. (auth)

44265 SEARCH FOR THE NUCLEON T = ½ ISOBAR IN THE np-INTERACTIONS. Vishnevskii, V. F.; Moroz, V. I.; Nikitin, A. V.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 336-7(Aug.1967). (In Russian).

The effective mass distributions are presented for the $p\pi^+\pi^+$ and $n\pi^-\pi^-$ combinations for 114 events of the reactions $np \rightarrow p n \pi^+\pi^+\pi^-\pi^-$ and $pn \rightarrow p n \pi^+\pi^+\pi^-\pi^-\pi^0$ proceeded in the 24 l propane bubble chamber bombarded by the neutrons with energy from 2 up to 10 GeV. The singularities in the mass region 1600-1700 MeV/c^2 that exceed the background curves by 3 standard deviations are found in the distributions. (auth)

44266 AN ATTEMPT TO DETERMINE THE PROTON-NUCLEON ELASTIC CROSS SECTION IN THE TeV REGION. Rybicki, K. (Inst. for Nuclear Research, Krakow). Nuovo Cim. (10), 51B: 187-9(Sept. 11, 1967).

An attempt is made to determine experimentally the value of the fraction of events in which elastic scattering leads to star production (visible evaporation) from 24 GeV protons irradiating an emulsion stack. This determination is essential for finding the elastic cross section. The calculations were based on the assumption that the density distribution known from the scattering of fast electrons on nuclei and on the known constitution of the nuclear emulsion. The interaction length was found to be 3.78 ± 2.07 m, and the cross section was $3.8^{+2.2}_{-1.1}$ b. This shows that the elastic cross section does not vanish in the TeV region. It is stated with 95% probability that the cross section is greater than 1.2 mb. It is added that five electron pairs starting on proton tracks were found. These together with five pairs found by another group yield an interaction length of 1.13 ± 0.36 m. (J.F.P.)

44267 STRANGE-PARTICLE PRODUCTION IN 10 GeV/c PROTON-PROTON REACTIONS. Holmgren, S. O.; Nilsson, S.; Olhede, T.; Yamdagni, N. (Univ. of Stockholm). Nuovo Cim. (10), 51A: 305-19(Sept. 21, 1967).

Strange-particle production in 10 GeV/c proton-proton collisions was studied. The following cross sections were obtained: $\sigma(\Sigma^+K^0) = (239 \pm 40)$ μb, $\sigma(\Sigma^-K^0) = (44 \pm 12)$ μb, $\sigma(\Lambda^0/\Sigma^0K^0) = (334 \pm 44)$ μb and $\sigma(K^0K^0) = (204 \pm 42)$ μb. In the final states $YNK\pi$ and $YNK\pi\pi$ there

is evidence for production of the following resonances: Δ(1236), (37 ± 9)%, N*(~1650), (18 ± 9)%, Σ(1383), (28 ± 7)% and Σ(1650), (16 ± 6)% (percentages of (339 ± 42) μb). No evidence was found for the production of two-body intermediate states corresponding to particles with defined mass and quantum numbers. (auth)

44268 HYPERON PRODUCTION IN INTERACTIONS OF 2.7 GeV/c ANTIPROTONS ON PROTONS. Fisher, G. P. (Univ. of Colorado, Boulder); Domingo, V.; Eide, A. J.; von Krogh, J.; Libby, L. Marshall; Sears, R.; Bohning, D.; Kernan, W.; Schroeder, L. Contract W-7405-eng-82. Phys. Rev., 161: 1335-43 (Sept. 25, 1967). (IS-1546).

Cross sections for hyperon production in 2.7-GeV/c $\bar{p}p$ interactions were measured. The values obtained are: $\sigma(\bar{\Lambda}\Lambda) = 113 \pm 15$ μb, $\sigma(\bar{\Sigma}^0\Lambda) + \sigma(\bar{\Lambda}\Sigma^0) = 66 \pm 13$ μb, $\sigma(\bar{\Xi}^0\Sigma^0) < 15$ μb, $\sigma(\bar{\Xi}^0\Xi^0) = \leq 2.8$ μb (90% confidence), $\sigma(\bar{\Sigma}^-\Sigma^+) = 30.7 \pm 9.4$ μb, $\sigma(\bar{\Sigma}^+\Sigma^-) = 1.0 \pm 5.4$ μb (large error resulting from subtraction), $\sigma(\bar{\Sigma}^+\Xi^-) = \leq 1.8$ μb (90% confidence), $\sigma(\bar{\Lambda}\Lambda\pi^0) = 65 \pm 25$ μb, $\sigma(\bar{\Sigma}^-\Lambda\pi^+ + \text{c.c.}) = 25.9 \pm 10.1$ μb, $\sigma(\bar{\Sigma}^-\Sigma^0\pi^+ + \text{c.c.}) = 2.9 \pm 2.9$ μb (one event), $\sigma(\bar{\Sigma}^+\Lambda\pi^- + \text{c.c.}) = 6.6 \pm 3.9$ μb, $\sigma(\bar{\Sigma}^+\Sigma^0\pi^- + \text{c.c.}) = 3.7 \pm 2.6$ μb, $\sigma(\bar{\Sigma}^-\Sigma^+\pi^0) = \leq 3.6$ μb (90% confidence), $\sigma(\bar{\Lambda}\Lambda\pi^+\pi^-) = 3 \pm 2$ μb, and $\sigma(\Lambda K^+\bar{p}) = 2.3 \pm 2.3$ μb (one event). The ratios of the cross sections for the two-body final states were compared with predictions of SU_3 and are in good agreement with the process being dominated by the exchange of an antisymmetric octet in the t channel. The angular distributions of $\bar{\Lambda}\Lambda$, $\bar{\Sigma}^-\Sigma^+$, and $\bar{\Lambda}\Lambda\pi^0$ final states clearly show the peripheral nature of these interactions. The differential cross section data for the interaction $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ were compared with parametric equations and three absorption models. Good fits to the data were achieved with each of these equations or models. (auth)

44269 POLARIZATION PARAMETER IN ELASTIC PROTON–PROTON SCATTERING FROM 0.75 TO 2.84 GeV. Neal, Homer A.; Longo, Michael J. (Univ. of Michigan, Ann Arbor). Contract Nonr-1224(23). Phys. Rev., 161: 1374-83(Sept. 25, 1967).

The polarization parameter in elastic proton-proton scattering was measured at 0.75, 1.03, 1.32, 1.63, 2.24, and 2.84 GeV by employing a double-scattering technique. An external proton beam from the Brookhaven Cosmotron was focused on a 3 in.-long liquid-hydrogen target and the elastic recoil and scattered protons were detected in coincidence by scintillation counters. The polarization of the recoil beam was determined from the aximuthal asymmetry exhibited in its scattering from a carbon target. This asymmetry was measured by a pair of scintillation-counter telescopes which symmetrically viewed the carbon target. The analyzing power of this system was previously determined in an independent calibration experiment employing a 40%-polarized proton beam at the Carnegie Institute of Technology synchrocyclotron. False asymmetries were cancelled to a high order by periodically rotating the analyzer 180° about the recoil beam line. Spark chambers were utilized to obtain the spatial distribution of the beam as it entered the analyzer; this information allowed an accurate determination of the corrections necessary to compensate for any misalignment of the axis of the analyzer relative to the incident-beam centroid. Values of the polarization parameter as a function of the center-of-mass scattering angle are given for each incident beam energy. The predictions of the Regge theory for polarization in elastic proton-proton scattering and recently published phase-shift solutions are compared with the experimental results. Surprisingly good agreement with the Regge predictions is found despite the low energies involved. (auth)

44270 ISOBAR PRODUCTION MECHANISMS IN PROTON–PROTON COLLISIONS AT 5 GeV/c. Colleraine, A. P.; Nauenberg, U. (Princeton Univ., N. J.). Phys. Rev., 161: 1387-1401 (Sept. 25, 1967).

Approximately 7500 four-prong proton-proton collisions at 5 GeV/c were studied using the BNL 80-in. hydrogen bubble chamber. The three principal reactions studied with their cross sections are: (a) $p + p \rightarrow p + p + \pi^+ + \pi^-$, 2.96 ± 0.12 mb; (b) $p + p \rightarrow p + p + \pi^+ + \pi^- + \pi^0$, 1.76 ± 0.07 mb; and (c) $p + p \rightarrow p + n + \pi^+ + \pi^+ + \pi^-$, 2.19 ± 0.09 mb. In each reaction both single and double N* production occurs and the decay angular distributions and density matrix elements were calculated whenever possible. These parameters indicate that pseudoscalar (pion) exchange appears to be dominant at low values of momentum transfer and that at higher momentum transfer absorptive effects become important. No evidence is found for ρ exchange in the reaction $p + p \rightarrow N^{*++} + N^{*0}$. The formation of the η- and ω-meson resonances is observed in reaction (b), but in none of the reactions studied is any significant ρ-meson production found to occur. In reaction (c) a deviation from phase space is found in the region of the 1580-MeV mass bump in the $p\pi^+\pi^+$ ($I = 3/2$) system which was observed by Alexander et al., but this departure from phase space is ascribed principally to N^{*++} and N^{*-} formation in this channel. (auth)

44271 OBSERVATION IN MICA OF TRACKS OF CHARGED PARTICLES FROM NEUTRINO INTERACTIONS. Russell, F. M. (Rutherford Lab., Chilton, Eng.). Phys. Lett., 25B: 298-300 (Sept. 4, 1967).

Evidence has been found which suggests that charged particles which may have been produced by neutrino interactions deep underground can leave observable tracks in mica. It is suggested that the majority of the tracks are caused by muons. (auth)

44272 NEUTRON–PROTON ELASTIC SCATTERING AT 15.7 MeV. Morton, W. T. (Univ. of Glasgow). Proc. Phys. Soc. (London), 91: 899-902(Aug. 1967).

The angular distribution of neutrons with an incident energy of 15.7 MeV elastically scattered from protons was measured in the angular range between 180 and 60° in the center-of-mass system using the nuclear emulsion technique. The results are consistent with the previous measurements at 14 MeV and yield a value of $\sigma(180°)/\sigma(90°) = 1.07 \pm 0.02$. By combining the present results with others at 14 MeV and fitting to an equation of the form $d\sigma/d\Omega = A + B \cos\theta + C \cos^2\theta$, values were obtained of $B/A = -0.033 \pm 0.022$ and $C/A = 0.042 \pm 0.026$. (auth) (UK)

44273 DOUBLE PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON–PROTON INTERACTIONS AT 2.7 GeV/c. Crawley, Henry Bert. Ames, Iowa, Iowa State Univ. of Science and Technology, 1966. 64p.

Thesis.

A study was made of the reaction $\bar{p}p \rightarrow \bar{p}p\pi^+\pi^-$ at an incident antiproton momentum of 2.7 GeV/c. The total cross section for this reaction was determined to be 1.93 ± 0.16 mb. The data were found to be consistent with 100% $N^*\bar{N}^*$ formation where N^* is the pion-nucleon resonance with $T = T_z = J = 3/2$, central mass value 1238 MeV, and width 125 MeV. It was observed that the $\bar{N}^*$ production is highly peripheral; that is, in the over-all center of mass system more than 50% of the $\bar{N}^*$'s are produced with a production angle whose cosine is greater than 0.8. A comparison of the data with the predictions of the form factor and absorption one-pion-exchange models was made. For the form-factor model only the contribution from the "double-isobar" diagram was included, as modified by the form-factor and off-shell corrections given by Selleri. The $T_z = 1/2$ diagram was excluded because it is calculated to contribute only 1% of that of the double-isobar diagram. Finally, the contribution from the Drell diagrams was excluded on empirical grounds, since the Drell diagrams contribute to zero or single resonance production, and the data are consistent with 100% double resonance formation. For the absorption model the predictions supplied by Hite and Jackson were compared with the data. It is found that both models account for the peripherality of the $\bar{N}^*$ production and for the effective mass distribution, but that neither model is successful in explaining the decay angular distributions. (Disser. Abstr.)

Strong (Meson-Induced)

44274 (INR–807/VI/PH) JET ANALYSIS BY THE METHOD OF PRINCIPAL AXIS. Danysz, Marian; Wojcik, Wojciech (Institute of Nuclear Research, Warsaw (Poland)). 1967. 17p. Dep.

The analysis of six-prong jets at 8 GeV/c π^+ p interactions by the method of principal axis does not show the existence of well-separated bodies which could be identified as the known resonances. The shape of the jets does not show the significant flatness. (auth)

44275 (ORO–2504-107) INVESTIGATIONS ON THE PROPERTIES OF K MESONS AND HYPERONS AND RELATED TOPICS IN HIGH ENERGY PHYSICS. Progress Report, October 1, 1966–September 30, 1967. Technical Report No. 703. Snow, G. A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). July 1967. Contract AT(40-1)-2504. 33p. Dep. CFSTI.

A broad-range study of the fundamental properties of elementary particles including their weak, electromagnetic, and strong interactions is being undertaken using bubble chamber, spark chamber, and counter techniques. In parallel, considerable effort goes into improving the state of the art of data analysis techniques and particle detection equipment. The progress of the experimental bubble chamber and spark chamber–counter activities are reviewed, and a summary of theoretical work is presented. (J.F.P.)

44276 (ORO–2504-108) ANALYSIS OF THE CASCADE FINAL STATES FROM 4.25 GeV/c K^-p INTERACTIONS. Wolsky, Gilbert (Maryland Univ., College Park. Dept. of Physics and Astronomy). Aug. 1967. Contract AT(40-1)-2504. 146p. Dep. CFSTI.

Thesis.

The Ξ^* final states at a cms energy of 3.01 GeV are studied, and a search is made for new higher mass resonances. The experiment was designed to study all possible decay modes of the

Ξ^*. Only final states containing a cascade hyperon are discussed. Evidence is presented on the existence of all known Ξ^*'s as well as for a previously unobserved $T = 3/2$ Ξ resonance. Evidence is also presented for the production of the K^* (890), κ, and ω. The cross sections for the observed final states are given. These cross sections are further broken down for several of the resonance subchannels. The two-body and quasi two-body final states are further analyzed in terms of the differential cross sections, polarization of the cascade, and the density matrix elements of the K^* (890). (J.F.P.)

44277 (SLAC-PUB-334) STUDY OF $\pi^\pm p$ 4-PRONG INTERACTIONS AT 16 GeV/c. Ballam, J.; Brody, A. D.; Chadwick, G. B.; Fries, D.; Guiragossian, Z. G. T.; Johnson, W. B.; Larsen, R. R.; Leith, D. W. G. (Stanford Linear Accelerator Center, Calif.). Aug. 1967. Contract AT(04-3)-515. 8p. (CONF-670934-1). Dep. CFSTI.

From International Conference on Elementary Particles, Heidelberg, Germany.

Results from two experiments performed at 16 GeV/c in the 80-inch hydrogen bubble chamber are reported. Slightly more than 10,000 events in the 4-prong topology in the $\pi^- + p$ experiment and 5,000 events in the $\pi^+ + p$ experiment were measured. Kinematical fits were made for the final states $p + \pi^\pm + \pi^+ + \pi^-$, $p + \pi^\pm + \pi^+ + \pi^- + \pi^0$, and $n + \pi^\pm + \pi^+ + \pi^- + \pi^+$. Cross sections for these final states are listed. In these four-body states strong signals for N^{*++}, N^{*0}, ρ^0, and f^0, and sizable enhancements in the A_1 and A_2 regions were observed, and their cross sections are listed. (auth)

44278 PARTIAL-WAVE ANALYSIS OF $\Sigma - \pi$ FINAL STATES NEAR 1 GeV. Bell, Robert B. (Univ. of California, Berkeley). Phys. Rev. Lett., 19: 936-9(Oct. 16, 1967).

The results of a partial-wave analysis of $\Sigma - \pi$ final states near 1 BeV from $K^-p \rightarrow \Sigma\pi$ and $K^-d \rightarrow \Sigma^-\pi^0 p$ interactions are presented. (auth)

44279 INVESTIGATION OF RESONANCES IN $\pi^0\gamma$-SYSTEM. Barmin, V. V.; Dolgolenko, A. G.; Meshkovskii, A. G.; Shebanov, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 338-43(Aug. 1967). (In Russian).

Searching resonances in $\pi^0\gamma$-system, the reaction $\pi^- + p \rightarrow n + x^0(x^0 \rightarrow \pi^0 + \gamma)$ at the π^--meson momenta 2.8 GeV/c was investigated. Besides the ω-meson with the decay mode $\omega \rightarrow \pi^0 + \gamma$, a resonance in the $\pi^0\gamma$-system with the mass about 1300 MeV was observed. (auth)

44280 ON THE Λ-POTENTIAL WELL DEPTH IN NUCLEAR MATTER. Prakash, Y.; Goel, S. P. (Kurukshetra Univ., Panjab, India). Nuovo Cim. (10), 51A: 340-53(Sept. 21, 1967).

An analysis of 59 mesonically decaying spallation hyperfragments produced in high energy K^- interactions and K^- captures in emulsions, is made. The results indicate that the most probable value of the Λ-potential well depth (D_Λ) in nuclear matter is $\leq (33 \pm 2.5)$ MeV. (auth)

44281 THREE-BODY FINAL STATES IN K^+p INTERACTIONS AT 3.5 GeV/c. De Baere, W. (Institut Interuniversitaire des Sciences Nucleaires, Brussels); Debaisieux, J.; Dufour, P.; (and others). Nuovo Cim. (10), 51A: 401-26(Sept. 21, 1967).

The three-body final states of K^+p at 3.5 GeV/c show large fractions of quasi-two-body processes, by abundant production of $K^*(892)$ and $N^*(1236)$. The $K^*(1400)$ is also observed in constructive interference with the $N^*(1236)$. The production and decay angular distributions of $K^*(892)$ are compared to the predictions of the peripheral models and to the results at 3 and 5 GeV/c. In particular, the agreement with the peripheral model with absorption, satisfactory at lower energy, tends to deteriorate as the energy increases. (auth)

44282 STUDY OF THE 6-PRONGED π^+p INTERACTIONS AT 5 GeV/c. Drevermann, H. (Univ., Bonn. Kernforschungsanlage, Bonn); Idschok, U.; Winter, G.; (and others). Phys. Rev., 161: 1356-74(Sept. 25, 1967).

As a contribution to the study of high-multiplicity phenomena, 3502 six-charged-prong π^+p interactions observed in a hydrogen bubble chamber were analyzed. The incident π^+ momentum was 5 GeV/c. The total cross section for this multiplicity is $\sigma = 1.33 \pm 0.05$ mb, mostly contributed by the following reactions: (A) $\pi^+p \rightarrow p3\pi^+2\pi^-$ (0.40 ± 0.03 mb), (B) $\pi^+p \rightarrow p3\pi^+2\pi^-\pi^0$ (0.61 ± 0.04 mb), and (C) $\pi^+p \rightarrow n4\pi^+2\pi^-$ (0.11 ± 0.02 mb). Individual particle momentum distributions, when compared with Lorentz-invariant statistical phase space, display deviations which are rather weak but still quite significant. The ρ^0 meson is abundantly produced in the first reaction (0.26 ± 0.05 mb). In the second reaction the ω meson is seen with a comparable cross section (0.26 ± 0.03 mb); χ^0 and η are also observed (50 ± 20 μb and 100 ± 20 μb, respectively, after correction for neutral decays). For both ρ^0 and ω resonances there is indication of spin alignment. $N^{*++}(1236)$ production is quite strong; the rate estimate is made difficult by the presence of distortions of the mass spectrum that are shown to be mostly concerned with the π^+p combinations of low c.m. velocity. It is suggested that the short lifetime of the $N^*(1236)$ resonance has some bearing on this effect, which indeed seems to affect also the ρ^0 and not the longer-lived ω. (auth)

44283 STRANGE-PARTICLE PRODUCTION BY 1.95 BeV/c π^+ IN HYDROGEN. Dagan, S.; Ma, Z. Ming; Chapman, J. W.; Fortney, L. R.; Fowler, E. C. (Duke Univ., Durham, N. C.). Phys. Rev., 161: 1384-6(Sept. 25, 1967).

Strange-particle production was studied in 30,000 pictures taken in the BNL 20-in. hydrogen bubble chamber exposed to a 1.95-BeV/c separated π^+ beam. Cross sections are presented and the production of resonant states is discussed. The three-particle final states are dominated by $Y_1^*(1385)$, $K^*(892)$, and $N_{\frac{3}{2}}^*(1688)$. The angular distribution of Σ^+ in the Σ^+K^+ final state is presented, and comparison with a resonance-exchange model is discussed. (auth)

44284 OBSERVATION OF RESONANCE IN THE $K_1^0K_1^0$ SYSTEM. Beusch, W.; Fischer, W. E.; Gobbi, B.; (and others). (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 25B: 357-61(Sept. 18, 1967).

An analysis was made of 2560 events in the final-state $K_1^0K_1^0n$ produced in π^-p interactions at 5, 7, and 12 GeV/c. The S^* (1070), f^0, and A_2 decaying into $K_1^0K_1^0$ were observed. Resonance parameters, cross sections, and branching ratios are given. (auth)

44285 BACKWARD πp ELASTIC SCATTERING AT 2.85 AND 3.30 GeV/c. Baker, W. F.; (CERN, Geneva); Carlson, P. J.; Chabaud, V.; Lundby, A.; Banaigs, J.; Berger, J.; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F. Phys. Lett., 25B: 361-4 (Sept. 18, 1967).

Backward elastic scattering was measured for π^+p at 2.85 and 3.30 GeV/c and for π^-p at 3.30 GeV/c. The π^+p angular distributions show steep backward peaks, whereas the π^-p distribution is flatter. At 2.85 GeV/c the π^+p differential cross section close to 180° is more than twice that at 3.30 GeV/c, supporting the assignment $J^P = 1^1/_2{}^+$ for $\Delta\delta$ (2420) resonance. The π^+p data at 2.85 GeV/c indicate the onset of a dip at $\cos\theta^{cm} \approx -0.97$. (auth)

44286 K^-p TOTAL AND ELASTIC CROSS SECTIONS AT 2.66 GeV/c. Ficenec, J. R.; Trower, W. P. (Univ. of Illinois, Urbana). Phys. Lett., 25B: 369-72(Sept. 18, 1967). (COO-1195-97).

At an incident kaon momentum of 2.66 GeV/c the total and elastic cross sections were measured to be 30.2 and 5.70 mb respectively. The elastic scattering angular distribution is dominated by a single diffraction peak; and this peak is fit to an exponential in momentum transfer t, the first order term is both necessary and sufficient. This fit evaluated at $t = 0$ is consistent with a purely imaginary forward scattering amplitude. Our data when compared with that of others indicate no shrinkage of the diffraction peak. The entire angular distribution was also fit to a Legendre series, with order 9 being required to represent the data. (auth)

44287 MASS MEASUREMENTS USING THE RANGE–ENERGY RELATION IN A HELIUM BUBBLE CHAMBER. Hyman, L. G.; (Argonne National Lab, Ill.); Loken, J.; Pewitt, E. G.; Derrick, M.; Fields, T.; McKenzie, J.; Wang, I. T.; Fetkovich, J.; Keyes, G. Phys. Lett., 25B: 376-80(Sept. 18, 1967).

Based on range measurements for reactions occurring in a helium bubble chamber, the following values for the Σ^+ mass and for the mass squared of the muon neutrino were obtained: $M(\Sigma^+) = (1189.16 \pm 0.12)$ MeV/c^2; $M^2(\nu_\mu) = (2.0 \pm 2.3)$ (MeV/c^2)^2. This value of $M^2(\nu_\mu)$ places an upper limit on $M(\nu_\mu) \leq 2.2$ MeV/c^2 (90% confidence). A value for the mean excitation potential in the helium range-energy relation of (42.5 ± 0.8) eV was also obtained. (auth)

44288 Σ^-K^+ ENHANCEMENT IN THE REACTION $\pi^-p \rightarrow \Sigma^-K^+\pi^0$. Weisbach, P. J.; Howard, C. G.; Palfrey, T. R. Jr.; Sahni, R. J. (Purdue Univ., Lafayette, Ind.). Phys. Lett., 25B: 302-4(Sept. 4, 1967).

The reaction $\pi^-p \rightarrow \Sigma^-K^+\pi^0$ was studied at incident pion laboratory momentum of 5.0 GeV/c. Evidence is presented that this reaction proceeds through excitation and subsequent Σ^-K^+ decay of the $N^*(1570)$ isobar. (auth)

44289 SEARCH FOR A BOSON RESONANCE OF MASS 960 MeV. Banner, M. (CEN, Saclay, France); Fayoux, M. L.; Hamel, J. L.; Zsembery, J.; Cheze, J.; Telger, J. Phys. Lett., 25B: 300-2(Sept. 4, 1967).

The spectrum of missing mass $M(X^-)$ in the reaction $\pi^-p \rightarrow p + X^-$ at 1.8 GeV/c was measured by means of a spectrometer with magnet and spark chambers to search for a $\delta^-(960$ MeV) resonance. (auth)

44290 BINDING ENERGIES OF HYPERNUCLEI FROM 2.3 BeV/c K^- INTERACTIONS. Huang, R.; Roalsvig, J. P.; Sahni, R. J.; Steinberg, P. H. (Univ. of Maryland, College Park). Can. J. Phys., 45: 2939-42(Sept. 1967).

Hypernuclear binding energies obtained from 43 uniquely identified mesic decays are reported. The values are in good agreement with the previous data. Reported also are binding energies of two short-range mesic spallation hyperfragments. (auth)

Particle Interactions and Properties (Theoretical)

General

44291 (AD-657959) DYNAMICAL THEORY OF BARYONS AND LEPTONS. Kursunoglu, Behram (Miami Univ., Coral Gables, Fla. Center for Theoretical Studies). Aug. 1967. 55p. (CTS-HE-67-4A). CFSTI.

An attempt is made to give dynamical description of baryons and leptons by the same wave equation yielding different mass spectra for each one of them. The wave equation leads to the following results: mass spectra for leptons and baryons (represented by orthogonal states) in the form of singlets and doublets, a third neutrino along with a third neutral lepton are predicted, the group SU(3,1) assumes the role of an internal symmetry group; thus pointing to the possibility of space time origin of internal symmetries. The theory is obtained from a classical nonlinear (Born-Infeld type) Lagrangian depending on the field variables E and H and only the wave equation for spin-½ particles is discussed. In this approach the field itself is treated as a wave function and therefore a way is found to get rid of Born-type square root. The wave equation involves, besides Dirac matrices, the 15 six-dimensional generators of the group SU(3,1). It is invariant under $G = SL(2,C) \times SU(3,1) \times L$ transformations, where the direct product contains the Lorentz group L. (auth)

44292 (CERN-67-21) QUARK MODEL OF THE ELEMENTARY PARTICLES. Feld, B. T. (European Organization for Nuclear Research, Geneva (Switzerland)). Aug. 24, 1967. 47p. Dep.

The interpretation of hadrons as simple bound states of quarks is discussed using nonrelativistic wave functions. The topics covered are the Gell-Mann–Ne'eman scheme, SU(3), the Sakata model in SU(3) representation, the quark model, the mixing angle and mass formula, and the quark model in SU(6). (J.F.P.)

44293 (COO-264-400) VECTOR CURRENTS AND SPECTRAL-FUNCTION SUM RULES. Sakurai, J. J. (Chicago Univ., Ill. Enrico Fermi Inst. for Nuclear Studies. Chicago Univ., Ill. Dept. of Physics). Aug. 1967. Contract AT(11-1)-264. 12p. Dep. CFSTI.

It is argued, on experimental grounds, that Weinberg's second sum rule must be abandoned for vector-current spectral functions as long as the vector-meson dominance approximation is qualitatively valid. (auth)

44294 (NYO-3732-1(Rev.)) ROLE AND DISTRIBUTION OF WRITTEN INFORMAL COMMUNICATION IN THEORETICAL HIGH ENERGY PHYSICS. Libbey, Miles A.; Zaltman, Gerald (American Inst. of Physics, New York. [Systems Development Div.]). Aug. 25, 1967. Contract AT(30-1)-3732. 115p. (AIP/SDD-1(Rev.)). Dep. CFSTI.

A study of "preprint" distribution in theoretical high energy physics has been conducted by the American Institute of Physics with support from the U. S. Atomic Energy Commission. Based on interviews with 45 high energy physicists and other preliminary studies, a questionnaire was developed and circulated to all known high energy theorists. A second questionnaire was sent to a representative sample of "preprint librarians" at various institutions both in the U. S. and abroad. Based on the facts, opinions, and suggestions so gathered the study concluded that an experiment with centralized "preprint" distribution is clearly desirable but that great caution must be exercised. Consequently, a two-step experiment, which would run for 18 months, has been designed for consideration by the physics community. The first step, to run for the full 18 months, would provide a centralized "preprint" announcement service and a directory of high energy theorists. In response to needs determined by the study, a format for the announcement service has been designed to indicate subject category, type and status of each entry. The second step, to run for the last 12 months, would add an experimental distribution system designed to introduce speed, efficiency and economy into informal communication and relieve the author of some of his present burden while retaining for the author all the controls he now has. This would provide for distribution of copies of "preprints," under strict control of the authors, directly to certain selected and authorized individuals. To help in determining the demand for such services charges would be made for about the last six months. (auth)

44295 PHYSICAL-SHEET PROPERTIES OF SECOND-TYPE SINGULARITIES. Branson, D. (Princeton Univ., N. J.). Nuovo Cim. (10), 51B: 239-40(Sept. 11, 1967).

It is proven that the second-type or non-Landau singularities do not appear in the interior of the physical sheet. The boundary of the physical sheet is defined as the locus of singularities obtained by replacing the internal masses m_i by αm_i, where α is a real parameter, independent of i, varying between one and infinity. It is concluded that no second-type singularities lie in the interior of the physical sheet, although they may lie on its boundary. (J.F.P.)

44296 ASYMPTOTIC BEHAVIOR OF STIELTJES TRANSFORMS. I. Woolcock, W. S. (University Coll., London). J. Math. Phys. (N. Y.), 8: 1270-5(June 1967).

Several theorems are proved concerning the asymptotic behavior of Stieltjes transforms as $|z|$ approaches infinity, in a sector of the complex z plane which does not include the cut in the transform. The asymptotic behavior of the transform is related to the asymptotic behavior, for large values of the argument, of the function whose transform is taken. (auth)

44297 CANONICAL FORM FACTORS AND CURRENT COMMUTATION RELATIONS. Chakrabarti, A. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.), 8: 1367-78(July 1967).

Starting with the vector (or axial vector) currents j^μ and the momentum operators P^ν, the canonical operator j is defined, such that instead of the four covariantly transforming components of j, there is a scalar $\tilde{j}^0$ and three other components $\tilde{j}$ undergoing Wigner rotations under Lorentz transformations. First a construction of j is given explicitly in terms of j and P^ν. But, since the transformation properties are not quite the most convenient ones, a subsequent generalized definition, leading to a convenient canonical parametrization of the matrix elements of $\tilde{j}$, is introduced. Then the physical significances of the canonical form factors thus obtained are studied. For vector currents $\tilde{j}^\nu$ the transformation properties correspond to a separation of the physical charge ($\tilde{j}^0$) and magnetic ($\tilde{j}$) form factors in any frame (and not only in Breit frame as for j). For nonconserved axial currents the matrix elements of $\tilde{j}^{0A}$ are related with mass-difference effects, and the partial conservation condition is expressed in terms of the canonical form factors. Then the application of the formalism to the limiting case of infinite momentum and small momentum-exchange is studied in detail. Next the canonical form factors for photoproduction processes are given explicitly. The possibility of constructing a canonical spin operator directly in terms of the vector and axial vector charges and the consequences for the "inner orbital" contribution to be added to obtain the total spin of a composite particle are studied. Some useful formulas are collected. (auth)

44298 REMARKS ON RELATIVISTIC STATISTICAL MECHANICS. II. HIERARCHIES FOR THE REDUCED DENSITIES. Hakim, Remi (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). J. Math. Phys. (N. Y.), 8: 1379-1400(July 1967).

The basis of relativistic statistical mechanics was discussed previously, and notions such as phase space, Gibbs ensemble, and distribution functions were defined. Hierarchies of equations for the reduced densities are considered. Extensive use is made of the beautiful methods of Klimontovich. In this way "classical mesic interactions" are dealt with neglecting "radiation" effects (i.e., "classical" emission of mesons). It is shown how the "renormalization of mass" affects the hierarchies obtained. Electromagnetic interactions are dealt with: neglecting radiation effects, and also including radiation effects. The latter case is treated on the basis of the Lorentz–Dirac equations and with the help of suitable modifications of the formalism. In this way a new approach to radiation phenomena (for instance, in plasmas) is obtained. Finally, as a matter of illustration, several well-known relativistic kinetic equations are rederived in a slightly improved manner (i.e., Vlasov and Landau equations). (auth)

44299 PARTICLELIKE SOLUTIONS OF A CLASS OF NONLINEAR FIELD EQUATIONS. Darewych, G. W.; Schiff, H. (Univ. of Alberta, Edmonton). J. Math. Phys. (N. Y.), 8: 1479-82(July 1967).

A procedure for generating integral relations satisfied by particlelike solutions of the class of nonlinear field equations $\Delta\phi = F^l(\phi)$ is proposed and used to develop the first few such relations. The relations are used to reduce the expression for the "energy" associated with the system; as an example, the case $F^l(\phi) = \phi - \phi^3$

is treated. It is shown generally that the variational bound to any of the possible energy values will approach the exact value from above if the trial functions are chosen to satisfy one of the integral relations, which is satisfied identically by the exact solutions. (auth)

44300 COMPOSITENESS CONDITIONS. Broido, M. M. (Univ. of Kent, Eng.). Nuovo Cim. (10), 51A: 577(Sept. 21, 1967).

A factual error in a recent letter of Yoshimura (Nuovo Cimento, 49A, 750 (1967)) referring to a paper by Broido and Taylor (Phys. Rev., 147, 993 (1966)) is corrected. Equation (9) of this letter is followed by the remark that the first term on the right-hand side of (9) was omitted in the discussion by Broido and Taylor but is important in the high-energy behavior of the function. It is postulated that the remark is quite wrong. It is stated that the constant appears explicitly as the first term in Fig. 14 of the cited paper by Broido and Taylor and can be ignored in the further propagator equations of that reference because they all refer explicitly to residues at the propagator pole and not to high-energy limits. (J.F.P.)

44301 COMPOSITENESS CONDITIONS FOR PARTICLES WITH IDENTICAL QUANTUM NUMBERS. Broido, Michael M. (Courant Inst. of Mathematical Sciences, New York); Taylor, John G. Phys. Rev., 161: 1301-3(Sept. 25, 1967).

Field-theoretic mechanisms by which two particles having identical quantum numbers can be exhibited as composites of other particles are discussed. If this can be done, then, contrary to what other authors have asserted, it can be done by letting the composite wave-function renormalization constants tend to zero. (auth)

Electromagnetic

Refer also to abstracts 44360 and 44391.

44302 (DESY-67/26) EQUAL TIME COMMUTATORS OF RENORMALIZED CURRENT OPERATORS IN PERTURBATION THEORY WITHOUT CUTOFF. Langerholc, J. (Hamburg Univ. (West Germany). Institut fuer Theoretische Physik (II)). Aug. 1967. 39p. Dep.

Equal time commutators of finite, renormalized current densities are considered in the first two orders of perturbation theory for the models of photon–nucleon and meson–nucleon interaction. After giving a definition of "equal times" for distributions, the commutators of vector currents in electrodynamics are calculated without the use of a cutoff for the cases where a higher symmetry exists, and where it is broken. Extra terms are found for the j_0,j_0 commutator as well as Schwinger terms. Divergences are obtained in this model for the j_k,j_k commutator and for the j_0,j_0 commutator in the meson model. Discrepancies arising from the use of a cutoff are discussed and the properties of the extra terms are examined. (auth)

44303 (NP-17037) SINGLE PHOTOPRODUCTION OF NEUTRAL π-MESONS ON HYDROGEN AT SMALL ANGLES BETWEEN 4 AND 5.8 GeV. Braunschweig, M.; Braunschweig, W.; Husmann, D.; Luebelsmeyer, K.; Schmitz, D. (Bonn Univ. (West Germany). Physikalisches Institut. Kernforschungsanlage, Juelich (West Germany)). [1967]. 15p. Dep.

The differential cross section of the reaction $\gamma + p \rightarrow p + \pi^0$ was measured at mean photon energies of 4.0, 5.0, and 5.8 GeV and pion center of mass angles between 0 and 60°. The results are compared with theoretical calculations based on reggeized vector meson exchange. (auth)

44304 EXPERIMENTAL LIMIT ON HIGH-ENERGY DIFFRACTION PHOTOPRODUCTION OF THE φ MESON. Tsai, Y. S.; Cox, J.; Martin, F.; Perl, M. L.; Toner, W. T.; Zipf, T. F. (Stanford Linear Accelerator Center, Calif.). Contract AT(04-3)-515. Phys. Rev. Lett., 19: 915-17(Oct. 16, 1967). (SLAC-PUB-328).

It is shown that a relatively small upper limit of 0.56 ± 0.2 μb can be placed on the high-energy (9 to 15 GeV/c) diffraction photoproduction of the φ meson on protons. This deduction is made from a recent measurement of the 5.5-GeV/c K^--meson flux produced at zero degrees in a beryllium target by a 16-GeV/c electron beam, and is obtained by attributing the entire flux of K^- mesons near zero degrees ($\theta < 0.36°$) to φ production. Three steps are involved in the calculation: first, the evaluation of the diffraction process to give the φ production; second, the introduction of the φ density matrix to give the subsequent K^- distribution; and third, the summation of this process over the bremsstrahlung spectrum. (L.B.S.)

44305 INTERACTIONS OF SLOW POSITRONS WITH H–IONS IN ALKALI METAL HYDRIDES. Ivanova, A. V.; Prokop'ev, E. P. (Inst. of Chemical Physics, Moscow). Teor. Eksp. Khim., 3: 471-7(July–Aug. 1967) (In Russian).

A self-consistent field method was used for calculating the probability of processes of slow positrons (in energy range from 0.025 to 5.46 eV) interactions with H^- ions. Angular correlation curves were obtained for γ-quanta at two-photon annihilation of positrons moving in the H^- ion fields at 0.025, 0.546, 1.365, 2.73, and 5.46 eV energies. Correlation of probabilities of annihilation and radiative capture of positrons by H^- ions with the probabilities of processes taking place with thermalized positrons explain the mechanism of annihilation of slow positrons in alkali metal hydrides (LiH). (tr-auth)

44306 ELECTROMAGNETIC MASS DIFFERENCES OF THE $\frac{1}{2}^+$ BARYONS CALCULATED WITH THE DASHEN–FRAUTSCHI METHOD. Kudryavtsev, V. A.; Pchelintsev, M. A. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 375-84 (Aug. 1967). (In Russian).

The electromagnetic mass differences of the $\frac{1}{2}^+$ baryons are estimated by means of the dispersion method. Each baryon is presented as a bound state of various baryon-meson pairs. A reasonable agreement with the experiment is obtained provided the states are used that take part in the baryon with the most weight. An additional result of the work is the estimate of the electromagnetic mixture between the π^0- and η^0- mesons. (auth)

44307 PHOTOPRODUCTION OF π^0-MESONS ON DEUTERON. Pazdzerskii, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 6: 385-8(Aug. 1967). (In Russian).

The corrections are considered to the general impulse approximation for π^0-meson photoproduction on deuterons due to multiple scattering. The effect of multiple scattering decreases the differential cross section by 25–30% for photon energies of 285–345 MeV. (auth)

44308 APPROXIMATE SATURATION OF THE COLLINEARIZED ALGEBRA OF VECTOR DENSITIES IN THE GROUP-THEORETIC LIMIT. Barnes, K. J. (Imperial Coll. of Science and Tech., London); Kazes, E. Nuovo Cim. (10), 51B: 128-39 (Sept. 11, 1967).

The collinearized algebra of isospin vector charge densities is saturated in the N and N* approximation, and the extent to which a solution exists is discussed in detail. Results are found which are an improvement over those previously obtained, and the group-theoretic predictions are clarified by an examination of the appropriate limit. (auth)

44309 ELECTRON–POSITRON BACKWARD SCATTERING AT HIGH ENERGIES. Gorshkov, V. G.; Gribov, V. N.; Lipatov, L. N.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 361-74(Aug. 1967). (In Russian).

Using the direct summation of Feynman graphs the double-logarithmic asymptotics of the backward scattering amplitude e^+e^-, $e^-\mu^+$ and of the backward annihilation $e^-e^+ \rightarrow \mu^-\mu^+$ were obtained. It appears that the contribution of virtual bremstrahlung photons which was absent at the forward scattering $e^-e^+ \rightarrow \mu^-\mu^+$, considerably changes the asymptotics. The expression for the sum of elastic scattering differential cross section and accompanying bremsstrahlung is calculated for an experimental situation when the momenta of bremsstrahlung quanta are limited by the condition $k_{\perp\perp}^2 \ll m^2$. (auth)

44310 INTERACTION OF A PARTICLE MOVING IN A NONLOCAL POTENTIAL WITH ELECTROMAGNETIC FIELD. Korolev, A. M. (Inst. of Physics, Kiev). Yadern. Fiz., 6: 353-60 (Aug. 1967). (In Russian).

A gauge invariant Lagrangian is constructed for a particle moving in a nonlocal potential. It is shown that from the requirement on the Lagrangian to be gauge invariant an additional interaction of the charged particle with the electromagnetic field arises. This interaction due to the momentum dependence of the nonlocal potential results from the existence of additional electric currents in the system. Expressions are obtained for the current density and for reduced probabilities of the electric and magnetic multipole transitions in the system. It is shown that the nonlocal currents do not affect the probabilities of the electric transitions and do affect essentially the values of the magnetic transitions. (auth)

44311 MEAN ENERGY OF A FREE ELECTRON IN A UNIFORM MAGNETIC FIELD IN ALEATORY ELECTRODYNAMICS. Braffort, Paul; Taroni, Adolfo (ESTEC, Noordwijk, Netherlands). Compt. Rend., Ser. A and B, 264: 1437-40(May 22, 1967). (In French).

The properties of a free electron placed in a uniform magnetic field were studied using the concepts and methods developed previously (Compt. Rend., 261: 4339(1965)). It was established that the results have some resemblance with those of quantum electrodynamics. (tr-auth)

44312 EXTENSIONS OF THE RENORMALIZATION GROUP. Astaud, Michele; Jouvet, Bernard (Institut Henri Poincare, Paris, College de France, Paris). Compt. Rend., Ser. A and B, 264: 1433-6(May 22, 1967). (In French).

An extension of the renormalization "group" makes it possible to calculate the graphs of the perturbation development of the self energies. The groups follow the classes characteristic of the invariant chosen. An example is given. (tr-auth)

44313 SCATTERING OF A PARTICLE BY A MODIFIED COULOMB FIELD. Tietz, T. (Univ. of Lodz, Poland). Z. Naturforsch., 22a: 1281-2(Aug. 1967).

An exact expression of the phase shifts for a modified Coulomb field is given. The collision between two particles of charges Ze and Z'e of reduced mass and relative velocity v(mv = ħk) is considered. (J.F.P.)

44314 DISPERSION SUM RULES FOR BARYON COMPTON SCATTERING. Vaishya, J. S. (National Physical Lab., New Delhi. Univ. of Delhi). Nuovo Cim. (10), 51A: 536-9(Sept. 21, 1967).

Assuming the high-energy behavior of its invariant amplitudes, new sum rules which relate the coupling constant of the baryon–photon vertex (charge and magnetic moment of the baryon) to that of the $B\beta B_\gamma$ vertex are derived. (J.F.P.)

44315 VIOLATION OF ISOTOPIC INVARIANCE AND THE PION FORM FACTOR. Efremov, A. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksp. Teor. Fiz., 53: 732-42(Aug. 1967). (In Russian).

A nonlinear integral equation for the pion form factor is obtained by assuming minimality of electromagnetic interaction and employing a certain approximation. An approximate analytic solution of the equation is presented. The form factor is found to depend only on the pion structure constant, the pion mass and pion mass difference. The mean square radius is 0.3 fermi. (auth)

44316 NOTE ON THE DECAY $\eta \rightarrow \pi^+\pi^-\gamma$. Smith, C. H. Llewellyn (Dept. of Theoretical Physics, Oxford). Nuovo Cim. (10), 51A: 554-9(Sept. 21, 1967).

The decay $\eta \rightarrow \pi^+ + \pi^- + \gamma$ is discussed assuming that the final-state mesons (π) are predominantly in the state T = 1, J = 1. If the decay is charge-conjugation invariant, the dipion state must have odd J, and it is reasonable to assume that J > 3 is highly suppressed relative to J = 1. The evidence for C conservation in this decay is not very strong; the measured $\pi^+\pi^-$ asymmetry is (1.5 ± 2.5)% which is compatible with various theories of C violation. However the angular distribution is quite compatible with J = 1. (J.F.P.)

44317 POLES AND RESONANCES IN η PHOTOPRODUCTION. Deans, S. R.; Holladay, Wendell G. (Vanderbilt Univ., Nashville). Phys. Rev., 161: 1466-72(Sept. 25, 1967).

Various combinations of poles and resonances were tried to determine just which combinations yield reasonable fits to the total and differential cross-section data for the process $\gamma + p \rightarrow \eta + p$. In each case the best values of the parameters were obtained by minimizing χ^2. Excellent fits ($\chi^2/N \approx 0.8$) are obtained for certain combinations of poles and resonances. All solutions with the $S_{11}(1570)$ resonance omitted have rather poor values of χ^2, and the $P_{11}(1400)$ resonance cannot be used in lieu of the $S_{11}(1570)$ in this process. Evidence is obtained for classifying the $F_{15}(1688)$ as a member of an octet rather than a 27-plet. For all the models considered here, the value of the η-nucleon coupling constant ($g_\eta^2/4\pi$) is less than 2, indicating a D/F ratio larger than $\frac{3}{2}$. (auth)

44318 C INVARIANCE AND THE ($\pi^0 e^- e^+$) AND ($\pi^0 2\gamma$) MODES OF THE η-DECAY PROCESS. Hiida, Kichiro (National Tsing Hau Univ., Hsinchu, Taiwan); Lee, Yee-yen; Sakuma, Tetsuro. Phys. Rev., 161: 1428-34(Sept. 25, 1967).

The transition probability of the electromagnetic decay process $\eta^0 \rightarrow \pi^0 + e^- + e^+$ is calculated in terms of both the angle and the energy difference between the electron-positron pair. It is found that the latter distribution is very sensitive to whether or not C invariance holds in the electromagnetic interaction of hadrons. A similar calculation is done also for the process $\eta^0 \rightarrow \pi^0 + 2\gamma$. The branching ratio between these two processes is also estimated and the results are discussed. (auth)

44319 RARE DECAY MODES OF THE η MESON. Young, Bing-lin (Indiana Univ., Bloomington). Phys. Rev., 161: 1620-30(Sept. 25, 1967).

The rare decay modes of the η meson are considered. Since in these decays the electromagnetic interaction for the leptons is well known, this work is concentrated on the strong interactions acting at the $\eta\gamma\gamma$ vertex. A model for the form factor of this vertex function is constructed. In this model the low-energy and the high-energy behaviors of the form factor are separately considered. The Bjorken limit is applied to determine the asymptotic behavior of the form factor. Predictions of the branching ratios of both the Dalitz pair and the direct decay modes are given as functions of the various parameters involved. Further experiments are needed to determine these parameters. A discussion of the model is also presented. (auth)

44320 VAN DER WAALS FORCE, DISPERSION THEORY, AND SINGULARITIES ON SECOND RIEMANN SHEETS. Soffer, Jacques; Sucher, Joseph (Univ. of Maryland, College Park). Contract AFOSR 500-66. Phys. Rev., 161: 1664-75(Sept. 25, 1967).

Previous work on the long-range electromagnetic forces between neutral particles is extended to obtain a more detailed understanding of the atomic or molecular van der Waals forces within the framework of covariant dispersion theory. It is shown that the modulation of the two-photon exchange potential $V_{2\gamma}$ from the London form $V_{2\gamma} \sim R^{-6}$ to the Casimir-Polder form $V_{2\gamma} \sim R^{-7}$ has an interesting dispersion-theoretic interpretation: It arises as a consequence of singularities in the momentum transfer t of the scattering amplitude F(s,t) in the physical region of t but on an unphysical Riemann sheet. The connection of the present approach with that of Casimir and Polder is explained. The one-photon exchange potential $V_{1\gamma}$ is also studied for systems bound by either short-range or Coulomb forces. Some of the modification of the usual assumptions of dispersion theory required to deal with the latter case are described. An erroneous statement in the literature regarding $V_{1\gamma}$ (in the static limit) is pointed out. The character of $V_{1\gamma}$ and $V_{2\gamma}$ arising from photon exchange between elementary particles is described and contrasted with the atomic case. Some of the advantages of a covariant approach to the problem of interatomic forces are discussed. (auth)

44321 SUPERCONVERGENT RELATIONS IN PION PHOTOPRODUCTION. Razmi, M. S. K.; Ueda, Y. (Univ. of Toronto). Phys. Rev., 161: 1655-9(Sept. 25, 1967).

Seven sum rules for pion photoproduction are derived in the context of SU(3) by assuming that the Regge trajectories $\alpha_{10}(0)$, $\alpha_{10^*}(0)$, $\alpha_{27}(0) < 0$. The sum rules are examined for approximate saturation with N, N*(1236), and N**(1518). (auth)

44322 HIGH-ENERGY LIMIT FOR THE PROBLEM OF TWO VECTOR CURRENTS. Horn, D. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Rev., 161: 1652-4 (Sept. 25, 1967). (CALT-68-122).

The Dashen-Gell-Mann assumption about the equal-time commutation relations of vector densities at infinite momentum is formulated as a high-energy theorem in a covariant form. This limit applies to the retarded product of two isovector conserved currents. An alternative formulation is given in terms of a scattering amplitude of isovector photons, from which a family of superconvergence relations is derived. (auth)

44323 ELECTRODISINTEGRATION OF THE DEUTERON. II. FINAL-STATE INTERACTIONS. McGee, Ian J. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 161: 1640-51(Sept. 25, 1967). (COO-881-103).

The effects of interactions between the outgoing nucleons on the cross sections for the inelastic electron-deuteron scattering process e + d → e + p + n are examined in detail. Results are presented as corrections to the theoretical cross sections which were calculated in a previous paper with a relativistic theory but neglecting final-state interactions. The changes are significant for the determination of the electromagnetic form factors of the neutron from the experimental cross sections. The method follows the treatment of final-state interactions given by Durand, extended to include the D state of the deuteron and the coupling between final-state partial waves of the same total angular momentum and parity. The resulting expressions for the quasielastic peak cross sections are expected to be valid in the momentum transfer range $0 \lesssim q^2 \lesssim 1.0\ (\mathrm{BeV/c})^2$. An alternative approach is suggested for the analysis of experiments at larger q^2 using an absorption model of the type which has been applied successfully to high-energy particle reactions. (auth)

44324 LOW-ENERGY THEOREM FOR PION PHOTOPRODUCTION FROM THE HYPOTHESIS OF PARTIALLY CONSERVED AXIAL-VECTOR CURRENT. Gaffney, G. W. (Stanford Univ., Calif.). Contract AF49(638)-1389. Phys. Rev., 161: 1599-1601(Sept. 25, 1967). (SLAC-PUB-305; ITP-261).

By using gauge invariance and the hypothesis of partially conserved axial-vector current, the pion-photoproduction amplitude at threshold is calculated to all orders in strong interactions neglecting terms of order $(m_\pi/M_N)^2$ but including terms of order m_π/M_N. The calculated cross section is consistent with experimental results for charged-pion photoproduction near threshold. (auth)

44325 FINAL-STATE INTERACTION EFFECTS IN THE ALGEBRA-OF-CURRENTS APPROACH TO THE THREE-PION DECAY MODES OF η AND K MESONS. Chiu, Y. T. (Univ. of Chicago); Schechter, J.; Ueda, Y. Contract AT(11-1)-264. Phys. Rev., 161: 1612-15(Sept. 25, 1967). (COO-264-355).

The current-algebra approach to $K \to 3\pi$ and $\eta \to 3\pi$ decays is simply modified to take account of final-state π-π interactions. Expressions are obtained for the relevant branching ratios in terms of certain assumed analytic forms for the I = 0 S-wave $\pi\pi$ scattering phase shift. It is shown how this mechanism may help to explain the anomalously low $(\eta \to 3\pi_0)/(\eta \to \pi_+\pi_-\pi_0)$ branching ratio without disturbing the "good" current-algebra results. (auth)

44326 ELECTROMAGNETIC PROPERTIES OF HADRONS IN A TRIPLET-SEXTET MODEL. De Souza, P. D.; Lichtenberg, D. B. (Indiana Univ., Bloomington). Phys. Rev., 161: 1513-22 (Sept. 25, 1967).

An investigation is made of the electromagnetic mass differences and magnetic moments of the baryons within the framework of a two-particle triplet-sextet model. The mass splittings are assumed to result from U-spin-invariant intrinsic mass splittings in the sextet and triplet, and from Coulomb and magnetic spin-spin interactions between the two particles. The two particles are taken to be an L = 0 orbital angular momentum state, and it is assumed that it is valid to use perturbation theory in the calculation of the electromagnetic mass differences. Sum rules and inequalities for the electromagnetic mass differences and magnetic moments are obtained, and the results compared with experiment. A calculation is also made of the electromagnetic mass differences of the 0^- and 1^- meson octets. Sum rules and inequalities are again obtained and the results compared with experiment. All predictions of the triplet-sextet model except one are in agreement with the presently available experimental data. One prediction relating the meson and baryon mass splittings disagrees with the experimental result by $1\frac{1}{2}$ standard deviations. The analogous prediction of the quark model is considerably worse. (auth)

44327 PION MASS DIFFERENCE AND CURRENT ALGEBRA. Bell, J. S.; Van Royen, R. P. (CERN, Geneva). Phys. Lett., 25B: 354-6(Sept. 18, 1967).

A recently derived sum rule for the electromagnetic mass difference of zero mass pions is extended to pions of finite mass. A particular correction, due to the variation of the function involved in the neighbourhood of a branch point, is estimated. It is quite small. (auth)

44328 GELL-MANN–OKUBO MASS FORMULA, CURRENT ALGEBRA AND PCAC. Brout, R.; Stern, H. (Univ. Libre, Brussels). Phys. Lett., 25B: 292-3(Sept. 4, 1967).

It is pointed out that the use of the Ademollo-Gatto theorem for the current algebra basis of the Gell-Mann-Okubo formula for baryons is rather dubious in regard to its precise meaning when a perturbing Hamiltonian is not available. A possible remedy by resorting to the algebra of axial currents, rather than vector currents, is suggested. (L.B.S.)

44329 A COMMENT ON BACKWARD π^0 PHOTOPRODUCTION AND THE $E_{1+}^{(3)}$ MULTIPOLE. Berends, F. A.; Donnachie, A. (CERN, Geneva). Phys. Lett., 25B: 278-9(Sept. 4, 1967).

It is shown that backward π^0 photoproduction is a sensitive test of the $E_{1+}^{(3)}$ multipole in the region of the first resonance and that the most recent throretical calculations are in good agreement with the latest experimental data. (auth)

44330 AN ISOBAR MODEL OF NUCLEON COMPTON SCATTERING. Weinman, Robert William. Pasadena, Calif., California Inst. of Tech., 1967. 81p.

Thesis.

The Compton scattering of photons by nucleons is described in terms of an isobar model for the resonant states, using a spin $\frac{3}{2}$ propagator and couplings at the vertices obtained from a phenomenological analysis of pion photo-production. The full Born term is taken into account, as well as contributions from π and η exchange in the t-channel. Numerical results are obtained at 90° in the center-of-mass system for the energy range 300 to 800 MeV which agree substantially with experiment. The recoil nucleon polarization and the cross-sections for polarized photons are also calculated over this energy range. (Disser. Abstr.)

Weak

Refer also to abstracts 44325, 44360, 44365, and 44368.

44331 (JINR-P2-3258) ZAKHVAT MYUONOV SLOZHNYMI YADRAMI I PROBLEMY SLABYKH VZAIMODEISTVII. (The Capture of μ Mesons by Complex Nuclei and the Weak Interaction Problems). Balashov, V. V.; Eramzhyan, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 133p. (In Russian). Dep.

A systematic account of the problems of μ-capture on nuclei is given. General hypotheses, assumed as a basis of the effective Hamiltonian of a weak μN-interaction, are considered. The main directions of the μ-capture experimental investigation and different theoretical models are analyzed. Reliability of the modern ideas about nuclear properties for getting the weak interaction constants from the experimental data is investigated. The program of further experiments on the μ-capture is discussed. (auth)

44332 ELECTROMAGNETIC CORRECTIONS, CURRENT ALGEBRA, AND THE INTERMEDIATE BOSON. Sirlin, A. (New York Univ., N. Y.). Phys. Rev. Lett., 19: 877-80(Oct. 9, 1967).

Assuming that the weak interactions are mediated by vector bosons, it is shown that the divergent parts of the second-order electromagnetic corrections to μ and β decays are identical in the limit of zero momentum transfer to the leptons. Therefore, in such a case the corrections to G_V/G_μ are finite. Implications of this result for the space–time part of the current algebra are briefly discussed. (auth)

44333 LOW-ENERGY THEOREM IN THE RADIATIVE DECAYS OF CHARGED PIONS. Das, T.; Mathur, V. S.; Okubo, S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 859-61(Oct. 9, 1967). (UR-875-212).

A low-energy theorem is derived for the structure-dependent axial-vector form factor in the radiative decay $\pi \to l\nu\gamma$ using current-algebra techniques. By saturation of the sum rule with a few low-lying resonances, an estimate is made which is compared with experiments. (auth)

44334 POSSIBLE CHECK OF NEUTRAL WEAK VECTOR-BOSONS THAT COUPLE TO $\mu^+\mu^-$ ONLY. Gruber, R.; Karpf, A. D. (Univ., Freiburg i. B.). Z. Phys., 205: 465-71(1967).

In connection with recent assumptions that weak vector-bosons might couple only to $\mu^+\mu^-$ currents (and not to e^+e^--ones) the question arises, how to check these bosons, since no colliding $\mu^+\mu^-$ beams are available. It is shown that this check could be performed by means of the resonance appearing in a pair production process from μ-beams and that this process would work μ-energies beyond 20 BeV. (auth)

44335 ENERGY SPECTRA OF NEUTRINO AND ANTINEUTRINO SCATTERING ON ELECTRONS. MEAN ENERGY LOSSES. Kerimov, B. K.; Romanov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1364-6(Aug. 1966). (In Russian).

Following up earlier studies on the spin and angular correlations in elastic and inelastic neutrino (antineutrino) –electron scattering, from which angular distributions and energy spectra of recoil electrons were obtained, the $\nu_e e \to \nu_e' e'$ and $\bar{\nu}_e e \to \bar{\nu}_e' e'$ type elastic scattering phenomena were further examined. In the first approximation of the perturbation theory of weak (V,A) interactions, the energy spectra of the neutrinos and antineutrinos scattered on electrons were obtained, taking into account the longitudinal polarization of recoil electrons and determining the effect of polarization of the final electron on the mean energy losses. It was found that at high antineutrino energy ranges, the mean energy losses in the $\bar{\nu}_e e$ scattering and the neutrino–electron scattering are practically constant. It is concluded that the recoil electrons in the above mentioned elastic scattering phenomena must be left-polarized. (TTT)

44336 POSSIBLE CP-NONINVARIANT EFFECTS IN $\pi\pi\gamma$ DECAY OF NEUTRAL KAONS. Costa, G.; Kabir, P. K. (Rutherford High Energy Lab., Chilton, Eng.). Nuovo Cim. (10), 51A: 564-9(Sept. 21, 1967).

The proposition is considered that $2\pi\gamma$ decays of neutral kaons may display appreciable CP-noninvariant effects even though these are not expected to include the possibility of large charge asymmetries. These effects are studied for a state $K_2^0 + \rho K_1^0$, that is, for an arbitrary superposition of K^0 and $\bar{K}^0$ states. The modes $K_1^0 \to \pi^+ + \pi^- + \gamma$ and $K_2^0 \to \pi^+ + \pi^- + \gamma$ are discussed. It is shown that one cannot expect asymmetries exceeding at most a few percent for any superposition of K_1^0 and K_2^0 whether or not one selects photons of a particular circular polarization. Also the modes $K_1^0 \to \pi^0 + \pi^0 + \gamma$ and $K_2^0 \to \pi^0 + \pi^0 + \gamma$ are briefly mentioned. (J.F.P.)

44337 WEAKLY INTERACTING PARTICLES IN THE ANISOTROPIC COSMOLOGICAL MODEL. Doroshkevich, A. G.; Zeldovich, Ya. B.; Novikov, I. D. Zh. Eksp. Teor. Fiz., 53: 644-53(Aug. 1967). (In Russian).

The possibility of a significant expansion anisotropy of the metagalaxy at various stages is currently being discussed in the literature. According to the "hot cosmological model" interaction between weakly interacting particles (neutrinos, gravitons)

and other particles and between themselves ceases during expansion. Various momentum components of freely moving particles are transformed differently during anisotropic expansion and the particles begin to move predominantly along a certain direction. It is shown that if such particles are taken into account the general pattern of anisotropic expansion and the physics of the processes are greatly modified at an early stage. (auth)

44338 RENORMALIZATION OF VECTOR COUPLING CONSTANTS IN LEPTONIC DECAY OF HADRONS. Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev., 161: 1558-62 (Sept. 25, 1967).

The renormalization of the vector coupling constant due to the strong interaction in the leptonic decay of hadrons is studied in the conventional field theory in which the time component of the weak vector current consists only of the terms which are bilinear in the usual way in the hadron field operators. It is shown that the renormalization of the vector coupling constant is negligible, even when the weak vector current is not conserved, and also completely independently of the transformation properties of the Hamiltonian and the weak vector current, as long as the off-mass-shell correction is negligible as regards the external mass continuation applied to the matrix element of the divergence of the weak vector current with respect to the initial and final hadrons in the respective leptonic decay. Essentially the same analysis applies also to the divergence of the weak axial-vector current. However, the assumption of negligible off-mass-shell correction implies in this case that axial-vector coupling is virtually absent, thus suggesting that the off-mass-shell correction is appreciable for the weak axial-vector current. The present analysis implies, when the weak vector and/or axial-vector currents are strictly conserved, that the baryons and the pseudoscalar bosons have, respectively, the same degenerate masses, as long as the respective fields appear explicitly in these weak currents. (auth)

44339 RADIATIVE CORRECTION TO β DECAYS. Suura, H. (Univ. of Minnesota, Minneapolis). Phys. Rev., 161: 1676-81 (Sept. 25, 1967).

The ultraviolet divergent part of the radiative correction to the pion β decay is evaluated generally, including the term induced by the radiative correction to the axial current. Although the divergence remains for the quark model, there exists a case when the divergences cancel, and this corresponds to a model where the β decay is due to the β decay of a fermion of unit negative charge. The model is applied to the general hadronic β decays, and it is shown that the correction to the vector current is always finite, although no definite conclusion can be drawn for the axial current. (auth)

44340 ABSOLUTE DISTINCTION BETWEEN PARTICLES AND ANTIPARTICLES AND CP VIOLATION IN $K_{L,S} \rightarrow 2\pi$. Sakurai, J. J. (Univ. of Chicago); Wattenberg, A. Phys. Rev., 161: 1449-50(Sept. 25, 1967). (COO-264-378; COO-1195-90).

It is shown how interference experiments involving $K_{L,S} \rightarrow 2\pi$ can serve to distinguish matter from antimatter in an absolute manner without recourse to any convention. (auth)

44341 FOUR-BODY LEPTONIC DECAYS OF HYPERONS. Singh, Y. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 161: 1497-1502(Sept. 25, 1967).

Using the techniques of current algebra, the four-body leptonic decays of hyperons of the type $B \rightarrow B' + \pi + e^- + \bar{\nu}_e$ were investigated. The predicted branching ratios for the favorable cases $\Sigma^+ \rightarrow p + \pi^+ + e^- + \bar{\nu}_e$ and $\Sigma^- \rightarrow N + \pi + e^- + \bar{\nu}_e$ are 0.35×10^{-7}, respectively. The covariant phase-space calculation for the four-body leptonic decay rate is given. (auth)

44342 RELATIONSHIP FOR THE VECTOR-MESON–LEPTON–NEUTRINO COUPLING CONSTANT. van der Merwe, P. du T. (Atomic Energy Board, Pelindaba, South Africa). Phys. Rev., 161: 1526-7(Sept. 25, 1967).

A relationship is derived for the weak coupling constant of the vector-meson-lepton–neutrino vertex employing the notion of a conserved vector SU(3) current and assuming a pole-dominance model. In the SU(3) limit, a certain restriction on the Cabibbo angle results so that the theory contains no free parameters. Utilizing these results, the decay rates for $\rho \rightarrow l + \nu$ and $K^* \rightarrow l + \nu$ are calculated. (auth)

44343 ON THE q^2 DEPENDENCE OF THE K_{l3} FORM FACTORS. d'Espagnat, B.; Gaillard, M. K. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Phys. Lett., 25B: 346-8(Sept. 18, 1967).

The Fubini–Furlan method is applied to the problem of the q^2 dependence of the K_{l3} form factors. It is shown that if $f_+(q^2)$ varies slowly then a rapid variation of $f_-(q^2)$ can reasonably be expected. Possible means of extracting theoretical information from data on $f_-(q^2)$ are briefly discussed. (auth)

44344 ALGEBRA CURRENTS AND THE DEVIATION FROM THE $|\Delta I| = \frac{1}{2}$ RULE IN $K \rightarrow 3\pi$ DECAY. Bouchiat, C.; Meyer, Ph. (CNRS, Orsay, France). Phys. Lett., 25B: 282-5(Sept. 4, 1967).

Starting from the usual current-current weak Lagrangian and using current algebra, the deviations from the $|\Delta I| = \frac{1}{2}$ rule in $K \rightarrow 3\pi$ decays are determined in terms of the $K \rightarrow 2\pi$ rates. The need for better data on $K \rightarrow 2\pi$ and $K \rightarrow 3\pi$ decays is stressed in order to arrive at a possible discrimination between a fundamental or a dynamic $|\Delta I| = \frac{1}{2}$ rule. As a by-product the PC conserving 3π decay of K_1^0 is calculated in the linear approximation. (auth)

44345 MUON STRUCTURE FROM SCATTERING ON POLARIZED PROTONS. Flamm, D.; Kummer, W. (Atominsitut, Vienna). Phys. Lett., 25B: 286-7(Sept. 4, 1967).

It is shown that a polarized proton target may considerably improve the analysis of a possible muon structure in small angle scattering. (auth)

Strong (General)

44346 QUARK PRODUCTION IN THE GALAXY AND SOME IMPLICATIONS FOR THEIR SEARCH. Pacini, F.; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Nuovo Cim. (10), 51B: 221-5(Sept. 11, 1967).

Various theoretical estimates for the concentration of quarks to be expected in various materials are presented. The production of $q\bar{q}$ pairs in collisions between cosmic protons and interstellar hydrogen gas, and the abundance of quarks in the ambient interstellar gas, that is, the fraction of the total number of quarks produced which were slowed down and thermalized by traversing xg cm^{-2} of interstellar gas are given. (J.F.P.)

44347 SATURATION OF EQUAL-TIME CHARGE COMMUTATION RELATIONS IN PERTURBATION THEORY. Brandt, R. A.; Kim, Y. S. (Univ. of Maryland, College Park). Contract AFOSR 500-66. Phys. Rev., 161: 1473-82(Sept. 25, 1967).

The quark-model equal-time charge commutation relations are studied in a simple perturbation-theoretic model. The summations over the intermediate states are explicitly performed. The zeroth-order results, such as the fact that one-particle intermediate states saturate the chiral SU(3) ⊗ SU(3) commutators at infinite momentum, are reviewed. In second order it is shown that the $[V_0,V_0] = iV_0$ and $[A_0,V_0] = iA_0$ commutation relations are satisfied provided the renormalized charges are used. It is argued that the relation $[A_0,A_0] = iV_0$ is still best handled at infinite momentum. However, higher-mass intermediate states do not vanish in this order if the observable axial charge renormalization is finite. (auth)

44348 BACKWARD SCATTERING IN THE QUARK MODEL. Watson, P. J. S. (Durham Univ., Eng.). Phys. Lett., 25B: 287-9(Sept. 4, 1967).

Backward scattering is examined in a quark model. A broad qualitative agreement with experiment is found. (auth)

44349 RECENT DEVELOPMENT OF A DYNAMICAL QUARK MODEL FOR HADRONS. Scheck, Florian (Univ., Freiburg i. B.). pp 210-38 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

A review is given of some recent applications of a simple dynamical quark model in hadron physics. It is assumed that the known mesons and baryons are real bound states of quarks and antiquarks with the internal wave functions given by their SU(6) classification. The following processes are discussed: elastic forward scattering amplitudes; inelastic meson-baryon and baryon-baryon reactions; rearrangement processes (proton-antiproton annihilation at rest and decay of the tensor mesons); mass relations for baryons; and electromagnetic properties of mesons and baryons. The essential dynamical assumption which is common to all applications is the additivity of quark vertices and the absence of multiquark effects. Those predictions of the model for which experimental data are available at the present time are found to be generally in good agreement with experiment. (L.B.S.)

44350 HADRON SPECTROSCOPY, DYNAMICAL GROUPS, AND MASS FORMULAS. Sinanoglu, Oktay (Yale Univ., New Haven). pp 239-75 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Various aspects of the group theoretic classification of mesons and baryons at rest are considered. Several purely phenomenological assignments considered for the higher hadron levels based on $U(6) \times U(6) \times O^L(3)$ as the static near-degeneracy group are first examined. Various noncompact groups and their quark model analogs are then discussed. Symmetry breaking in higher supermultiplets and generalizations of mass formulas are treated. The

theory is then applied in detail to the meson spectrum, which leads to a number of mass and quantum number predictions like G-parities which are compared with experiment. After eliminating the various stages of mass splittings central masses for the supermultiplets of G_F are obtained. The results indicate the group $[U(6) \times U(6); (6,6)^{-}] \times SO(3,1) \times SU(1,1)$ as the G thus far most consistent with the meson levels. The baryon spectrum and its quark models are discussed in the last section. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstracts 44319 and 44380.

44351 (ORNL-TM-1945) GRAPHS OF SCATTERED PARTICLE ENERGIES VS SCATTERING ANGLES, AND GRAPHS OF CENTER-OF-MASS SCATTERING ANGLES VS LABORATORY SCATTERING ANGLES FOR NUCLEON-NUCLEON REACTIONS FROM 25 TO 3500 MeV AND FOR PION-NUCLEON REACTIONS FROM 25 TO 2500 MeV. Bertini, Hugo W.; Guthrie, Miriam P.; Pickell, Elsie H. (Oak Ridge National Lab., Tenn.). Aug. 18, 1967. Contract W-7405-eng-26. 37p. Dep. CFSTI.

Graphs are presented illustrating the laboratory energy of the scattered nucleon vs the laboratory energy of the incident nucleon where the scattering angle is a parameter for incident nucleon energies ranging from 25 to 3500 MeV. The same types of data are presented for pion-nucleon reactions with energies from 25 to 2500 MeV. Graphs of the scattering angle in the center-of-mass system vs the scattering angle in the laboratory system at various reaction energies for the same reactions and over the same energy ranges are presented. The data are applicable to the checking and the understanding of the results from an intermediate-energy intranuclear-cascade calculation. (auth)

44352 SHORT-RANGE REPULSION IN LOW-ENERGY SCATTERING. Serebryakov, V. V.; Shirkov, D. V. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 6: 400-11(Aug. 1967). (In Russian).

A method of calculation for the high-energy contributions to the partial wave equations for the low-energy scattering is proposed. These contributions are of the repulsion type for symmetric amplitudes. It is shown for the s-wave and p-wave pion-pion scattering that the account of repulsion described by the "short-range interaction constant" γ can essentially change the scattering lengths and the widths of the low-energy resonances. (auth)

44353 SOME RESONANCE SOLUTIONS FOR HIGHER PARTIAL WAVES IN THE π-π SCATTERING. Orlov, I. I.; Parfenov, Yu. V. (Inst. of Mathematics and Computer Center, Novosibirsk, USSR). Yadern. Fiz., 6: 396-9(Aug. 1967). (In Russian).

The equations for the $\pi\pi$-scattering are analyzed in the resonance approach taking the higher partial waves into account. The account of the f^0-meson does not change the width of the ρ-meson as compared with the sp-approach but results in the considerable narrowing of the σ-meson. A limit on the position of the f^0-meson is obtained in agreement with the experiment. (auth)

44354 CALCULATION OF SOME SPIN-2 MESON COUPLINGS. Cook, P. A. (Univ. of Manchester, Eng.). Nuovo Cim. (10), 51A: 578-82(Sept. 21, 1967).

A simple quark model is used for the coupling of spin-2 mesons to pairs of pseudoscalars. The coupling of the meson (f_0) to two mesons (π) and the meson K*(1420) are considered. Partial widths for the decays $f_0 \rightarrow A_1 + \pi$, $f_0 \rightarrow 2\pi$, and $K^*(1400) \rightarrow K + \pi$ are calculated. (J.F.P.)

44355 CURRENT ALGEBRAS AND VECTOR-MESON DECAYS. Baracca, A. (Univ., Bologna). Nuovo Cim. (10), 51A: 560-3(Sept. 21, 1967).

Applications of the chiral SU(3) commutation relations, PCAC, partially conserved tensor-current hypothesis, and the local U(12) current algebra to the decays of vector mesons are reported. The decay rates for $\rho^0 \rightarrow \pi^+ + \pi^-$, $\phi \rightarrow K^+ + K^-$, $K^{*0} \rightarrow K + \pi$, and the decay widths for $\omega \rightarrow \pi^0 + \gamma$, $\rho^0 \rightarrow \pi^0 + \gamma$, $\phi \rightarrow \pi^0 + \gamma$, and $\phi \rightarrow \rho + \pi$ are calculated. (J.F.P.)

44356 SUPERCONVERGENCE CONDITION AND SCALAR NONET. Watanabe, K. (Dublin Inst. for Advanced Studies). Nuovo Cim. (10), 51A: 551-3(Sept. 21, 1967).

The superconvergence conditions are examined by assuming the partially conserved vector-current hypothesis for the strangeness-changing vector currents. Scalar meson mass, coupling constant, and width are calculated. (J.F.P.)

44357 SUPERCONVERGENCE RELATIONS IN π-A_1 SCATTERING. Srivastava, P. P.; Korthals Altes, C. P. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim. (10), 51A: 533-5(Sept. 21, 1967).

Sum rules are discussed for the axial vector meson A_1 and π scattering, with restriction made only to the forward (t = 0) case. Nontrivial, superconvergent dispersion relations are found, and the coupling constant sum rules obtained by approximately saturating these relations by the contributions of a number of s-channel resonances are discussed. It is concluded that the presently known resonances cannot saturate these sum rules. (J.F.P.)

44358 SUPERCONVERGENCE RELATION IN BACKWARD N-$\bar{N}$ SCATTERING. Roy, D. P. (Univ. of California, Riverside). Phys. Rev. Lett., 19: 806-9(Oct. 2, 1967).

Suitable linear combinations of the N-N helicity amplitudes are constructed to eliminate the contribution of the deuteron and the virtual singlet trajectories. Thus four out of the five independent and crossing-odd N-N scattering amplitudes are shown to be superconvergent. However, the pseudoscalar-, scalar-, and vector-meson contributions fail to saturate most of these superconvergence relations. (auth)

44359 CURRENT ALGEBRAS AND POLE DOMINANCE APPLIED TO THREE-POINT FUNCTIONS. Brown, Stanley G.; West, Geoffrey B. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 19: 812-15(Oct. 2, 1967).

It is demonstrated that the "hard-pion" process $A_1 \rightarrow \rho\pi$ can be correctly calculated by "soft-pion" techniques. The difficulty in earlier treatments by these methods is shown to be due to the fact that dispersing with an inappropriate invariant fixed omits important pole contributions. The derivation of the Kawarabayashi-Suzuki relation is criticized. (auth)

44360 STRONG AND WEAK DECAYS WITH MESON EMISSION IN THE QUARK MODEL. Lipkin, Harry J.; Rubinstein, H. R.; Stern, H. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 161: 1502-4(Sept. 25, 1967).

Strong, electromagnetic, and weak decays are described in the independent-quark model as single quark transitions with no symmetry higher than isospin assumed for the interaction. Relations between quark model and symmetry predictions, e.g., $SU(6)_w$, and the possibility of experimental tests are discussed. Strong decays of a three-quark baryon supermultiplet with L = 2 are treated in detail. Many predictions are given which can provide tests of symmetries and of the model when more data are available. Present data indicate rough agreement, but are inconclusive. (auth)

44361 BJORKEN LIMIT AND SUM RULES FOR THE π^0 LIFETIME AND THE $\rho\omega\pi$ COUPLING CONSTANT. Young, Bing-lin (Indiana Univ., Bloomington). Phys. Rev., 161: 1615-19(Sept. 25, 1967).

The Bjorken limit is applied to obtain sum rules for the lifetime of π^0 and for the vector-meson coupling constants. In particular the predictions that $g^2_{\rho\omega\pi}/4\pi = 0.53 \pm 0.1$ and $\tau_{\pi^0} \simeq (0.84 \pm 0.83) \times 10^{-16}$ sec are obtained. The latter is in good agreement with the experimental value $(0.89 \pm 0.18) \times 10^{-16}$ sec. From knowledge of the approximate value of $g_{\rho\omega\pi}$, it is concluded that the high-energy behavior of the $\pi^0\gamma\gamma$ vertex function is not important to the pion lifetime. The results of this calculation constitute a consistency condition on the plausibility of the Bjorken limit. (auth)

44362 SUPERCONVERGENT DISPERSION RELATIONS AND MESON COUPLINGS. Venturi, Giovanni (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 161: 1438-48(Sept. 25, 1967). (COO-264-377; EFINS-67-21).

Superconvergence relations for vector-meson-meson scattering are saturated with nonets of vector and pseudoscalar mesons. It is found that, with this truncation in the saturation, the only meaningful sum rules are the ones selected by the infinite-momentum limit and evaluated near zero momentum transfer. On demanding only isospin invariance at the vertices and considering all possible scattering and reaction processes, one finds a consistent set of equations for the meson coupling constants. The conditions are examined under which collinear U(4) or collinear U(6) emerge from this complete set of equations. On considering only the equations obtained from vector-pseudoscalar scattering, one is able to relate nonet symmetry breaking at the vertices to nonet breaking in the masses. Use of SU(3) at the vertices unambiguously leads to results consistent with collinear U(6) symmetry of the vertices. (auth)

44363 MESON SPECTRUM AND SUPERCONVERGENCE SUM RULES FOR THE $J^{PC} = 2^{++}$ MESONS. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Phys. Rev., 161: 1687-94 (Sept. 25, 1967).

The mesons with masses $m \leq 2000$ MeV are classified by means of a simple quark model and the contributions that individual resonances make to meson superconvergence sum rules are calculated. To a good approximation it is found that only the two lowest supermultiplets are needed. For the case of elastic scattering of pseudoscalar mesons with $J^{PC} = 2^{++}$ mesons, it is found that in some sum rules one of these supermultiplets is suppressed for

kinematic reasons. Predictions are made and compared with both higher-symmetry predictions and experiment. (auth)

44364 SEMIRELATIVISTIC QUARK MODEL FOR MESONS. Horwitz, Paul (New York Univ., N. Y.). Phys. Rev., 161: 1415-27(Sept. 25, 1967).

A quark model of mesons is presented which treats the kinematics, including spin, exactly, but neglects the effects of retardation in the interaction. Starting with the two-particle Dirac equation with a static square-well potential, it is found that tightly bound physical solutions exist only for certain special cases. In addition, there are unphysical solutions which correspond to the binding of a positive-energy spinor to a negative-energy spinor. The solution used in the Fermi-Yang model of the pion is unphysical in this sense. For continuously varying potentials, the equations contain singularities which arise from the presence of unfilled negative-energy states. These make the two-particle Dirac equation unreliable for interaction energies which are comparable to the masses involved. Using a reduced form of the Bethe-Salpeter equation in the ladder approximation for an instantaneous interaction, which is represented by an S-wave separable potential, the wave functions of the π and ρ mesons are computed. The π lifetime is calculated, which comes out in good agreement with the observed value for a quark mass of 3.1 BeV. The π-ρ mass splitting has the right sign, but is too large, for all values of the quark mass. (auth)

44365 PHENOMENOLOGICAL MODEL OF STRONG AND WEAK INTERACTIONS IN CHIRAL U(3) ⊗ U(3). Cronin, Jeremiah A. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 161: 1483-94(Sept. 25, 1967). (COO-264-374; EFINS-67-19).

A phenomenological model for the strong and weak interactions of an octet of pseudoscalar mesons in chiral U(3) ⊗ U(3) is constructed and discussed. In this model the effect that the partially conserved axial-vector current hypothesis (PCAC) and the transformation properties of the interaction Lagrangian in chiral U(3) ⊗ U(3) have on the transition amplitudes for various meson processes can be studied. The processes considered are the leptonic and nonleptonic decays of K mesons, the strong interaction decay $\eta'(959) \rightarrow \eta(549) + 2\pi$, the s- and p-wave scattering lengths for pion-nucleon scattering, and meson-meson scattering. Low-energy pion-pion scattering is discussed as an illustration of the fact that for process involving more than one soft pion, PCAC and the algebra of currents are not sufficient to give unique results in general. (auth)

44366 KINEMATIC EFFECTS AND THE B MESON. Gleeson, Austin M. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 161: 1523-6(Sept. 25, 1967). (NYO-3399-98).

Two mechanisms for the enhancement of threshold resonances are described. These mechanisms are applied to the case of the B meson. (auth)

44367 SUPERCONVERGENCE SUM RULES FOR $2^+ - 0^-$ SCATTERING. Papastamatiou, N. J.; Pakvasa, S. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 161: 1554-7(Sept. 25, 1967). (NYO-3399-113; SU-1206-113).

The kinematics for $2^+ - 0^-$ elastic scattering is developed and the asymptotic behavior of the invariant amplitudes is determined assuming (a) Regge behavior and (b) a Froissart bound. The corresponding sum rules are written down and an approximate saturation with a few low-lying single-particle states is attempted. In general, such saturation is not obtained. (auth)

44368 PHENOMENOLOGICAL METHOD FOR KAON INTERACTIONS. Zumino, B. (New York Univ. CERN, Geneva). Phys. Lett., 25B: 349-50(Sept. 18, 1967).

The method of phenomenological fields and Lagrangians can be generalized to describe interactions involving strange particles. The examples of the strong interactions between pions and kaons and of the weak leptonic decays of the kaon are described in detail. (auth)

44369 FURTHER STUDY OF THE I = 1 $K\bar{K}$ STRUCTURE NEAR THRESHOLD. Astier, A. (College de France, Paris); Cohen-Ganouna, J.; Della Negra, M.; Marechal, B.; Montanet, L.; Tomas, M.; Baubillier, M.; Duboc, J. Phys. Lett., 25B: 294-7(Sept. 4, 1967).

The present experimental evidence for an I = 1 ($K\bar{K}$) enhancement in $p\bar{p}$ annihilations at rest and at 1.2 GeV/c is summarized. Different possible interpretations for the enhancement are proposed. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 44146, 44348, 44351, 44365, and 44428.

44370 (IS-1690) THE APPLICATION OF A SUM RULE TO A REGGE MODEL FOR THE HIGH ENERGY πN SYSTEM. Beaupre, James Vincent; Hammer, Charles L. (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 61p. Dep. CFSTI.

Theoretical $\pi^{\pm}p$ total and elastic charge exchange differential cross sections and polarizations were fitted to 259 high energy data points, under the assumptions of either a four Regge pole model or a three pole and a cut model. The generalized Restignoli-Sertorio-Toller sum rule, generalized to include the cut, is used to constrain the charge exchange forward amplitude under the assumptions that this amplitude is dominated by either the ρ and ρ' poles or by the ρ pole and a ρ-P cut. The resulting fits, having χ^2's of 438 for the P + P' + ρ + ρ' model and 426 for the P + P' + ρ + cut model, generally agreed with the data. However, the use of the sum rule strongly depressed the calculated charge exchange polarization for both models. (auth)

44371 SHRINKAGE EFFECTS AND ONE-PION EXCHANGE. Wolf, G. (Stanford Linear Accelerator Center, Calif.). Phys. Rev. Lett., 19: 925-8(Oct. 16, 1967). (SLAC-PUB-343).

It is shown that the experimental data on $d\sigma_{N^{*++}\rho^0}$ dt and on the energy behavior of $\sigma_{N^{*++}\rho^0}$ for the $\pi^+p \rightarrow N^{*++}\rho^0$ interaction are well described by a one-pion-exchange model if the finite widths of N^{*++} and ρ^0 are taken into account. The OPE model was also compared with the process $\bar{p}p \rightarrow \bar{N}^{*++}N^{*++}$, and was found to be in remarkable agreement with the data. The observed shrinkage for the width of the forward peaks in the cross sections for $\bar{N}^{*++}$ N^{*++} is accounted for by the OPE model in the same manner as for the $\pi^+p \rightarrow N^{*++}\rho^0$ interaction. (L.B.S.)

44372 ANALYSIS OF πN SCATTERING USING PARTIAL-WAVE DISPERSION RELATIONS IN THE W PLANE. Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev. Lett., 19: 862-4(Oct. 9, 1967).

Extensive use was previously made of partial wave dispersion relations in the s (square of total energy in the cm system) plane in analyzing π + N scattering. Similar calculations are performed for the $I = \frac{1}{2}$, $J = \frac{1}{2}$ partial waves in the W plane, and some striking features are found. (J.F.P.)

44373 π^--MESON CHARGE EXCHANGE REACTION ON NUCLEI OF BOUND HYDROGEN. Ponomarev, L. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 389-95(Aug. 1967). (In Russian).

The previously proposed "model of large mesomolecules" is evolved. The consequences of this model are considered as well as the new experiments where it can be useful for the analysis. (auth)

44374 SOME REMARKS ON THE POLARIZATION DATA FOR PION-NUCLEON SCATTERING. Predazzi, E.; Soliani, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim. (10), 51A: 427-38(Sept. 21, 1967).

The recently measured data on the polarization of the recoil proton in $\pi^{\pm}p \rightarrow \pi^{\pm}p$ and $\pi^-p \rightarrow \pi^0n$ are shown to imply that the ratio of the spin-flip amplitudes over $\sin\theta$ ("residual spin-flip amplitudes") exhibits the same diffractive behavior typical of elastic-scattering amplitudes at high energies and small angles. The resulting exponential forward peak is much narrower than that for the spin-nonflip amplitudes. It is also found that the assumption that the complete scattering amplitudes are purely imaginary leads to contradictions. In an absorptivelike framework, the contribution of the real to the imaginary part of the amplitudes can be estimated to be of the order of 10% in agreement with other experimental data. (auth)

44375 REGGE TRAJECTORIES FOR TWO YUKAWA POTENTIALS. Bali, N. F.; Chu, Shu-yuan; Haymaker, Richard W.; Tan, Chung-I (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 161: 1450-8(Sept. 25, 1967). (UCRL-17475).

The leading Regge trajectories generated by two Yukawa potentials of different ranges are studied by both analytical and numerical methods. It is found that several new features appear which a are not present in the single-Yukawa case. The behavior of the trajectories is investigated in detail as a change is made gradually from the single- to the two-Yukawa-potential case, paying close attention to the appearance of branch cuts other than the usual right-hand cut in the leading trajectories. It is noticed that these cuts, if present in relativistic theory, can play important roles in explaining effects such as the polarization in the π^-p charge-exchange reaction. (auth)

44376 DOUBLE SCATTERING OF MESONS IN THE QUARK MODEL FOR BARYONS. Sarker, A. Q. (Univ. of Islamabad, Pakistan). Phys. Rev., 161: 1435-7(Sept. 25, 1967).

The effects of the double scattering of mesons were evaluated in the quark model for baryons. The following relations among the meson-baryon scattering amplitudes hold in general: (i) $K^+p - K^-p = \pi^+p - \pi^-p + K^+n - K^-n$, (ii) $\langle K^+\Sigma^-|\pi^-p\rangle = \langle K^0\Xi^0|K^-p\rangle = \frac{1}{2}\langle K^+\Xi^-|K^-p\rangle = \langle K^0\Xi^-|K^-n\rangle = \langle\pi^+\Sigma^-|K^-p\rangle$. The strong Johnson-Trei-

man relations were also obtained by taking into account the spin (apart from the unitary spin) wave function of the baryon within the quark model, so that there is an exchange of spins when two quarks are interchanged [a weaker assumption than SU(6)]. (auth)

44377 SU(3) SYMMETRY BREAKING IN THE $Y_0^*(1405)$ COUPLINGS. Weil, C. (Univ. of Minnesota, Minneapolis). Phys. Rev., 161: 1682-6(Sept. 25, 1967).

It is shown that the low-energy $\bar{K}N$ scattering data imply a large breaking of SU(3) symmetry in the $Y_0^*(1405)$ couplings. The coupling of this resonance state to the $\bar{K}N$ system is found to be several times larger than what is expected on the basis of assigning it to a $\frac{1}{2}^-$ SU(3) singlet and using its decay width into $\pi\Sigma$. Two theoretical calculations are carried out in order to understand this breaking effect. The first calculation uses a vector-exchange-potential model; the second, algebras of currents. The calculations succeed in relating the symmetry breaking to mass differences. The $\frac{1}{2}^-$ singlet SU(3) assignment for the resonance retains its validity. (auth)

44378 PION–NUCLEON SPIN-FLIP SUM RULE. Gerstein, I. S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., 161: 1631-5(Sept. 25, 1967). (MIT–2098-320).

Current algebra and the hypothesis of partially conserved axial-vector current are used to derive a sum rule for the spin-flip pion-nucleon scattering amplitude analogous to the Weisberger-Adler (W-A) sum rule for the non-spin-flip amplitude. It is found that such a sum rule requires information about the weak amplitude for axial-vector–nucleon scattering, in contrast to the W-A relation, which requires no such information. As a byproduct a decomposition of this weak amplitude into tensor covariants is given, which is more useful than those previously appearing in the literature. This expansion applies to polar-vector–nucleon scattering as well, and hence is relevant to Compton scattering. (auth)

44379 NEW INTERPRETATION OF THE $\pi N \to \pi N$ SCATTERING DATA AND THE CHARGE-INDEPENDENCE HYPOTHESIS. Tornqvist, Nils A. (Univ. of Helsinki). Phys. Rev., 161: 1591-8(Sept. 25, 1967).

The isospin dependence and the charge independence of the $\pi N \to \pi N$ differential cross sections is studied by a graphical method reported previously. An interesting and not well-known observation is made, namely, that for the non-spin-flip and the spin-flip cross section separately the triangular inequalities are accurately satisfied as equalities at low energies (below 200 MeV), and in backward scattering also at higher energies. This observation, which is believed to be of a fundamental nature, does not have a trivial explanation in the usual formalism. A suggestion is made as to how the formalism could be modified so that the observation would have a simple interpretation as a new kind of unitarity condition. (auth)

44380 REGGE-POLE MODEL FOR THE SCATTERING MAXIMA IN πN AND NN SCATTERING AND THE NO-COMPENSATION MECHANISM. Chiu, Charles B.; Chu, Shu-yuan; Ling-lie (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 161: 1563-70(Sept. 25, 1967). (UCRL-17302).

The dip-bump structure in the low-energy π^+p elastic differential cross section was studied. It is found that a zero in the helicity nonflip amplitude of the P′ trajectory gives a natural explanation of this structure. At the same time the high-energy π^+p total and differential cross sections, the π^+p polarizations, and the π^-p charge-exchange differential cross-section data were consistently fitted. The helicity nonflip amplitude of the P′ trajectory will vanish at $\alpha_{P'} = 0$ if the P′ trajectory chooses what we call the no-compensation mechanism. Consistent with the π^+p solution, the pp and $\bar{p}p$ total and differential cross sections can also be well fitted. The secondary maximum in the low-energy $\bar{p}p$ differential cross section is reproduced. (auth)

44381 SUM RULES FOR ALMOST BACKWARD PION–NUCLEON ELASTIC SCATTERING. Griffiths, David; Palmer, William (Johns Hopkins Univ., Baltimore). Phys. Rev., 161: 1606-9(Sept. 25, 1967).

Sum rules are derived, assuming Regge asymptotic behavior, for the πN elastic scattering amplitudes at $u = 0$. The four sum rules obtained are found to be consistent with each other and with the forward-scattering sum rule of Sakita and Wali if ρ and $f^0(1250)$ are included in the t channel. Without the f^0, the sum rules are inconsistent. Predictions are made for the nucleon–ρ–meson coupling constants. (auth)

44382 ASYMPTOTIC $\pi^-p \to \pi^0 n$ AND $\pi^-p \to \eta$ CROSS SECTIONS FROM SEPARABILITY AND UNITARITY. Cushing, J. T. (Univ. of Notre Dame, Ind.). Phys. Lett., 25B: 339-40(Sept. 18, 1967). (COO-427-68).

Differential cross sections for $\pi^- + p \to \pi^0 + n$ and $\pi^- + p \to \eta + n$ interactions are predicted using a model recently proposed by Predazzi (Nuovo Cimento, 48: 1014(1967)) for high-energy two-body inelastic scattering amplitudes based on unitarity and the separability of the inelastic amplitudes. (L.B.S.)

44383 DISPERSION SUM RULES AND HIGH-ENERGY πN SCATTERING. Meshcheriakov, V. A.; Rerikh, K. V.; Tavkhelidze, A. N.; Zhuravlev, V. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 25B: 341-3(Sept. 18, 1967).

The dispersion sum rules for the high-energy πN scattering parameters are derived with the aid of Cauchy's theorem. Comparison with experiment is made. (auth)

44384 CALCULATION OF THE $A\bar{K}N$ COUPLING CONSTANT USING A NEW KN FORWARD DISPERSION RELATION. Martin, A. D.; Poole, F. (Univ. of Durham, Eng.). Phys. Lett., 25B: 343-5(Sept. 18, 1967).

A modified forward dispersion relation for KN scattering is proposed which is more suitable than the conventional relation for the determination of the $A\bar{K}N$ coupling constant. The value $g_{A\bar{K}N}^2 = 5.0^{+1}_{-3}$ is obtained. (auth)

44385 MESON REGGE EXCHANGE AMPLITUDES AND THE πN RESONANCE SPECTRUM. Barger, V.; Phillips, R. J. N. (CERN, Geneva). Phys. Lett., 25B: 351-4(Sept. 18, 1967).

Regge exchange amplitudes in πN scattering are related to the πN bound state and resonance spectrum, through sum rules based on analyticity. Various ambiguities in dynamical approximations are noted. Characteristic features of ρ exchange can be consistently generated, but the method seems unsuitable for Pomeranchuk amplitudes. (auth)

44386 MEAN LIFE OF THE MULTIPLE-POLE RESONANCE. Gien, Tran Trong (Memorial Univ. of Newfoundland, St. John's, Can.). Can. J. Phys., 45: 2965-74(Sept. 1967).

The mean life of the multiple-pole resonance is calculated by different methods of approach. The inconsistency of the results makes it worthwhile to question the validity of the nonexponential decay laws. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 44348 and 44380.

44387 DOUBLE-SCATTERING MODEL FOR HIGH-ENERGY BACKWARD PROTON–DEUTERON SCATTERING. Bertocchi, L.; Capella, A. (CERN, Geneva). Nuovo Cim. (10), 51A: 369-400 (Sept. 21, 1967).

The impulse series for nucleon-deuteron elastic scattering is generalized near the backward direction. It is shown that double scattering, which is known to be small near the forward direction, becomes dominant (as compared to single scattering) near the backward direction. As an application, pd elastic scattering is considered at 1, 1.3 and 1.5 GeV where a large-angle experiment was recently done. The double-scattering contribution accounts for both the angular distribution and the energy dependence of the large-angle pd cross section. The predicted values of the backward cross section are also in reasonably good agreement with the experimental results. (auth)

44388 SCALAR MESON, PION–PION INTERACTION, AND NUCLEAR FORCES. Barker, Bruce M. (Univ. of Windsor, Ont.); Gupta, Suraj N.; Haracz, Richard D. Phys. Rev., 161: 1411-14(Sept. 25, 1967).

The σ-meson exchange contribution to nuclear forces is compared with the pion-pion interaction effect and with the two-pion exchange contribution, and the aspects of similarity between these three processes are discussed. The $\sigma + \pi$ exchange contribution to nuclear forces is also obtained. (auth)

44389 EFFECT OF HIGHER BARYON RESONANCES ON THE TWO-PION EXCHANGE CONTRIBUTION TO NN SCATTERING. Durso, John W. (Michigan State Univ., East Lansing). Contract AT(11-1)-1051. Phys. Rev., 161: 1636-9(Sept. 25, 1967). (COO–1051-6).

The consistency of πN and NN scattering demonstrated in a previous paper is reexamined by reparametrizing the Bowcock–Cottingham–Lurie model for πN scattering to include the effects of baryon resonances beyond the well-known $\Delta_\delta(1236)$. The reparametrization, though unphysical in the sense of requiring a negative width for the $N_\gamma(1518)$ to achieve a best fit to low-energy πN data, reduces the χ^2 of the model by a factor of 8.6. Used as input for the NN calculations, this new parametrization is found to yield essentially the same results as when only the N and $\Delta_\delta(1236)$ are included in the πN model. Arguments are presented to explain the apparent insensitivity of the NN predictions to the fine details of the πN model. (auth)

44390 THE FOUR-BODY DECAY OF THE ^{9}Be HYPERNUCLEUS. Chlebowska, D.; Wrzecionko, J.; Zielinska-Pfabe, M.

(Inst. for Nuclear Research, Warsaw). Phys. Lett., 25B: 309-13(Sept. 18, 1967).

The energy distribution as function of the p-α, α-α, and p-2α relative energies for the ${}^{9}_{\Lambda}\mathrm{Be} \rightarrow \alpha + \alpha + p + \pi^-$ decay were calculated. The effect of the final-state interaction and the structure of the ${}^{9}_{\Lambda}\mathrm{Be}$ hypernucleus was taken into account. The results were compared with experiment. (auth)

44391 ON PROTON–PROTON BREMSSTRAHLUNG. Felsner, G. (CERN, Geneva). Phys. Lett., 25B: 290-2(Sept. 4, 1967).

The cross section for proton-proton bremsstrahlung was calculated for soft photons in a model independent way. Comparison with experiments was made. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 44444 and 44560.

44392 EXTENSION OF THE WIGNER–ECKART THEOREM. Galindo, A. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 293-7(Sept.-Oct. 1967). (In Spanish).

By using elementary properties of the group representation theory the Wigner-Eckart theorem is established for any compact group. (auth)

44393 SOME CLEBSCH–GORDAN COEFFICIENTS FOR THE SU_6 GROUP. Asherova, R. M.; Smirnov, Yu. F.; Troitskii, V. E. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 116-19(Jan.-Feb. 1967). (In Russian).

The Clebsch–Gordan tables for the direct product of the irreducible representations 56×56 for the SU_6 group are given and the calculation method is briefly described. (R.V.J.)

44394 SUn,1 REPRESENTATION FOR THE HARMONIC OSCILLATOR. Bisiacchi, G.; Chersi, T. (Univ., Trieste, Italy). Nuovo Cim. (10), 51B: 195-8(Sept. 11, 1967).

It is shown in the case of the harmonic oscillator that the choice of the spectrum generating algebra and of its representations is not unambiguous, yet it allows the correct determination of the energy spectrum. A noncompact algebra such that all the physical states are contained in a single irreducible representation is considered. (J.F.P.)

44395 A NOTE ON LIE-ALGEBRA INHOMOGENIZATIONS. Berzi, V. (Univ., Milan. Istituto Nazionale di Fisica Nucleare, Milan); Gorini, V. Nuovo Cim. (10), 51B: 207-9(Sept. 11, 1967).

A theorem is proven which exactly defines the conditions under which nonequivalent representations produce isomorphic inhomogenizations. (J.F.P.)

44396 RECURSION RELATIONS FOR U(3) ISOSCALAR FACTORS. Tumanov, V. S. (Moscow State Univ.). Yadern. Fiz., 6: 426-30(Aug. 1967). (In Russian).

The recursion relations for the U(3) isoscalar factors have been derived. The infinitesimal operator matrix elements are used in the Gelfand–Zetlin basis. Some advantages of the nonunimodular group are preliminarily considered. Some applications of the obtained relations are discussed. (auth)

44397 DISCRETE DEGENERATE REPRESENTATIONS OF THE CONFORMAL GROUP IN SPACE–TIME. Maduemezia, A. (International Centre for Theoretical Physics, Trieste, Italy). Nuovo Cim. (10), 51A: 320-39(Sept. 21, 1967).

The homomorphism between the conformal group in space-time and the noncompact group $SU_{2,2}$ is used to derive three new types of unitary irreducible representations of the conformal group. These representations are realized in Hilbert spaces of the so-called harmonic functions. Two of them are equivalent (vector) representations, while the third is a projective (spinor) representation. All three are degenerate and of the discrete-series type. The generators of the physical operations of the conformal group are realized as differential operators — some of them explicitly in terms of the variables of the representation space. Matrices of the translation and dilatation operators are calculated between certain harmonic-function states. The dilatation operator is found to connect only states whose values of a certain parameter m differ by two or zero. It is suggested that, should degenerate discrete-series representations of the type described be relevant to the correct classification of fundamental particles, a simple explanation of the experimentally observed discrete mass spectra might be found in this property of the dilatation operator. (auth)

44398 DEFORMATION AND CONTRACTION OF LIE ALGEBRAS. Levy-Nahas, Monique (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.), 8: 1211-22(June 1967).

The theory of deformation of Lie algebras is considered. A connection is established with the usual contraction theory, which leads to some "more singular" contractions. As a consequence it is shown that the only groups which can be contracted in the Poincaré group are SO(4,1) and SO(3,2). (auth)

44399 BRANCHING THEOREM FOR THE SYMPLECTIC GROUPS. Hegerfeldt, G. C. (Univ., Marburg, Ger.). J. Math. Phys. (N. Y.), 8: 1195-6(June 1967).

A theorem analogous to the Weyl branching law for the unimodular groups is derived for Sp(2n). (auth)

44400 DECOMPOSITION OF THE UNITARY IRREDUCIBLE REPRESENTATIONS OF THE GROUP SL(2C) RESTRICTED TO THE SUBGROUP SU(1,1). Sciarrino, A. (Univ., Rome); Toller, M. J. Math. Phys. (N. Y.), 8: 1252-65(June 1967).

The unitary irreducible representations of the group SL(2C) belonging to the principal series restricted to the subgroup SU(1,1) are decomposed into a direct integral of unitary irreducible representations of SU(1,1). The matrix elements of the unitary operator which performs the decomposition are given explicitly and used to obtain a relation between the matrix elements of the unitary irreducible representations of the groups SL(2C) and SU(1,1). Similar identities between the matrix elements of nonunitary representations of these groups are obtained by means of analytic continuation. The relevance of these results to the theory of complex angular momentum and of high energy nearly forward scattering is pointed out. (auth)

44401 RELATION BETWEEN "OUTER" AND "INNER" MULTIPLICITY FOR SU(2) AND SU(3). Gruber, B. (Duke Univ., Durham, N. C. Istituto Nazionale di Fisica Nucleare, Naples). J. Math. Phys. (N. Y.), 8: 1436-9(July 1967).

The Clebsch–Gordan series for SU(3) is given in terms of irreducible representations of SU(3) such that the "outer" multiplicity of the Clebsch–Gordan series is related to the "inner" multiplicity of irreducible representations. (auth)

44402 UNITARY REPRESENTATIONS OF THE LORENTZ GROUP AND PARTICLE DYNAMICS. Rafanelli, Kenneth (Queen's Coll., Flushing, N. Y.). J. Math. Phys. (N. Y.), 8: 1440-2(July 1967).

The quantum dynamics of particles with arbitrary spin implied by explicit use of the infinite dimensional unitary representation of the Lorentz group, introduced by Majorana, is examined. Comparison with the classical theory of spinning particles shows that this unitary representation leads to a quantum mechanical analog of the relativistic pure gyroscope. (J.F.P.)

44403 DECOMPOSITION OF TENSORS OF THE CLASSICAL GROUPS. Tompkins, Donald R. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.), 8: 1502-14(July 1967).

A tensor symmetrization procedure obtained in a recent publication [Phys. Rev. Letters 16: 1058 (1966)] is shown to support rather than disprove Weyl's tensor symmetrization theorem. This "extended" symmetrization procedure differs from Weyl's approach in that to construct a subspace irreducible under GL(n,c) one starts with a set of formal states (symmetrized tensors with formal index values) spanning an irreducible representation of the permutation group rather than starting with a single formal state. Extended symmetrization is often more useful than Weyl's approach because the states obtained are highly organized and because it also yields an efficient independent state selection method for the symmetrization procedures using modified Young symmetrizers and Wigner projection operators. The state organization obtained makes it possible to show that the nonorthogonality which is present for bases obtained with Young symmetrizers can be easily removed. The state organization also makes it possible to simplify the task of recoupling symmetrized tensor representations to gain a simply coupled form. This form enlarges the class of Clebsch-Gordan and recoupling coefficients which can be evaluated by tensor methods. Group matrices and Lie group generator matrix elements are also obtained by tensor methods. Extended symmetrization using unitary representation Wigner projection operators based on unitary representations is shown to result in orthogonal states although usually not the orthogonal states desired. The usual Young symmetrizers are shown to often be more useful than modified Young symmetrizers or Wigner projection operators. (auth)

44404 DOES THE CONDITION Z = 0 IMPLY FURTHER SYMMETRIES? Yoshimura, T. (Univ., Innsbruck). Nuovo Cim. (10), 51A: 540-1(Sept. 21, 1967).

An example is shown in which the field of a composite particle with interaction breaking the symmetry of elementary particles makes the current not conserved even in the limit $Z_3 \rightarrow 0$, so that

the symmetry is not derived from the compositeness condition. (J.F.P.)

44405 SPIN POLARIZATION. PART I. REST FRAME POLARIZATION STATES. Steiger, A. D.; Fritz, K. J. (Univ. of California, Livermore). Nuovo Cim. (10), 51A: 461-528. (Sept. 21, 1967).

The restrictions imposed by space-time reflection symmetries on the maximum number of real parameters determining a coherent as well as an incoherent mixture of positive-mass one-particle spin states are considered. The decomposition of the rest frame spin-density operator into multipole components is used extensively. A relation expressing the polarization multipole operator components of arbitrary rank in terms of the first-rank operator components has been derived. The maximum number of measurements necessary to specify a spin-density operator exhibiting discrete space-time symmetries and the corresponding restrictions on the multipole expansions which are invariant under these symmetry operations are obtained. For some discrete space-time symmetries there exist no nontrivial half-integral spin states. (auth)

44406 DYNAMICAL SYMMETRIES AS FUNCTION GROUPS ON DYNAMICAL SPACES. Simoni, A. (Univ., Naples); Zaccaria, F.; Vitale, B. Nuovo Cim. (10), 51A: 448-60(Sept. 21, 1967).

Dynamical symmetries are analyzed from the viewpoint of function groups defined on an n-dimensional dynamical space. Limiting the analysis to semi-simple Lie algebras, a number of interesting results obtain: in particular, the order of the function group (i.e. the number of functionally independent generators employed to obtain an explicit realization of the algebra) is related to the number of independent Casimir operators; and the rank of the algebra is shown to be necessarily smaller or equal to n. By applying this method to the recently proposed "invariance" and "noninvariance" dynamical groups, we show that the characteristic features of these groups are independent of any specific Hamiltonian and simply depend on their function group structure. Many general problems related to the explicit realization of "invariance" and "noninvariance" dynamical groups are therefore seen in a completely general frame. (auth)

44407 SOME PROPERTIES OF A CLASS OF GENERALIZED INONUE-WIGNER CONTRACTIONS. Hegerfeldt, G. C. (Univ., Marburg, Ger.). Nuovo Cim. (10), 51A: 439-47(Sept. 21, 1967).

A recently proposed contraction procedure is investigated with possible applications to dynamical groups in mind. Rather restrictive necessary and sufficient conditions are derived such that a Lie algebra L can be contracted by this method to $L_0 \oplus A$ where $L_0 \subset L$ and A is some algebra. The general results are applied to some physically interesting cases. (auth)

44408 GRAPHS FOR STUDYING CHARGE INDEPENDENCE AND UNITARY SYMMETRIES IN PARTICLE PHYSICS. Tornqvist, Nils A. (Univ. of Helsinki). Phys. Rev., 161: 1581-90 (Sept. 25, 1967).

The properties of the triangular diagram for studying consequences of charge independence in particle physics is discussed in detail. Simple rules are given for how to draw and how to interpret the diagrams. The isospin calculations and the corresponding diagrams for reactions of practical interest are given. (auth)

44409 SYMMETRY PRINCIPLES AND FUNDAMENTAL PARTICLES. Foley, Henry M.; Ruderman, Malvin A. (eds.). A Series of Books in Physics. San Francisco, W. H. Freeman and Co., 1967. 532p. $10.00.

Fourteen papers are included under the following topics: noncompact groups and dynamical applications; quark models; current algebra, weak interactions, and chiral symmetries; and recent developments in field theory and S-matrix theory. Individual abstracts are prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 44349, 44350, 44410-44413, 44418, 44419, 44429-44431, 44444, 44464, and 44557.

44410 THE PAST OF A DELUSION: ATTEMPTS TO WED INTERNAL AND SPACE-TIME SYMMETRIES. Coleman, Sidney (Harvard Univ., Cambridge, Mass.). pp 3-45 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Various attempts to construct a symmetry group that combines space-time and internal symmetries are reviewed. The accuracy of the Gell-Mann-Okubo formula and the success of nonrelativistic U(6) are briefly discussed. O'Raifertaigh's theorem is discussed in more detail, and the possibility of constructing a relativistic U(6) theory is considered. A theorem is presented which was established in an attempt to prove the conjecture that any group that both puts a finite number of particles in a supermultiplet and admits a nontrivial S-matrix must be a direct product of the Poincare group and an internal symmetry group. The possibility of constructing schemes in which groups restrict the dynamics but are not symmetry groups in the usual sense is considered. Three such schemes are discussed: subsidiary condition theories; the Dashen-Gell-Mann approach; and saturation of commutators. (L.B.S.)

44411 WAVE EQUATIONS WITH INFINITE COMPONENTS. Nambu, Yoichiro (Univ. of Chicago). pp 161-70 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

The problems associated with the use of the Bethe-Salpeter and Bargmann-Wigner type equations for describing hadrons as composite systems are pointed out. An attempt is made to find general dynamical equations which fall somewhere between the Bethe-Salpeter and Bargmann-Wigner equations, starting with the simple problem of describing the form factor of a particle and considering first a scalar particle. The same approach is considered for fermions, using the set of spinors $\{\psi_a^m\}$ which corresponds to representations of the Lorentz group. (L.B.S.)

44412 LECTURES ON CHIRAL SYMMETRIES AND SOFT PION PROCESSES. Nambu, Yoichiro (Univ. of Chicago). pp 391-454 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967. (EFINS-66-107).

An introductory review is first given of the basic ideas leading to the concept of chiral symmetry (or γ_5 invariance). The question of interpreting and justifying the PCAC hypothesis on a theoretical basis is considered from various angles. Different models of chiral symmetry are then examined: Gell-Mann-Levy type model; Nishijima-Gursey type model; Marsjak-Okubo type model; spontaneous breakdown of chiral symmetry; and derivative coupling model. The consequences of the PCAC hypotheses in problems where only one pion is involved are discussed. Application to weak and electromagnetic processes is made, which includes photo-pion and electro-pion production, neutrino-pion production, leptonic decays of baryons and mesons, and nonleptonic decays of baryons. Many-pion processes are then examined, which give more information about chiral symmetry. Two examples are discussed-low energy π-N scattering and the nonleptonic decay of the K meson. (L.B.S.)

44413 SYMMETRIES, BROKEN SYMMETRIES, CURRENTS, AND CHARGES. Robinson, Derek W. (CERN, Geneva). pp 457-513 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Various properties of physical symmetries are described within the framework of the Haag-Kastler algebraic theory of local observables. The mathematical results concerning topological algebras are first summarized, which are subsequently needed to define the general framework and explain its intended physical content. The restrictions placed by causality requirements on the group of all physical symmetries are then discussed, and it is deduced that this group has at most the structure of the semi-direct product of the Poincare group and a normal subgroup of internal symmetries. Consideration is then given to properties of local currents, the concept of a spontaneously broken symmetry is discussed, and a proof is given of Goldstone's theorem based on very general assumptions. Finally the definition of charge operators constructed from locally conserved currents is discussed, and the possibility of constructing such operators from nonconserved currents is demonstrated. These results are discussed in context with the current algebra theory. (L.B.S.)

Applications (Electromagnetic and Weak)

44414 MASS-SPLITTING THEOREM FOR NON-UNITARY GROUP REPRESENTATIONS. O'Raifeartaigh, L. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Rev., 161: 1571-5(Sept. 25, 1967). (NYO-3399-102).

It is shown that a rigorous theorem on the impossibility of obtaining a stable hadron mass spectrum from unitary representations of Lie groups due to Jost and Segal can be generalized to the case of (nonuniformly) bounded group representations. The only link with unitarity that need be retained is the assumption that the mass-squared operator is self-adjoint. (auth)

44415 SYMMETRY RESTRICTIONS ON K $\rightarrow 2\pi$ AMPLITUDES. Schechter, Joseph (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 161: 1660-3(Sept. 25, 1967). (COO-264-380; EFINS-67-33).

The restrictions on the $K \to 2\pi$ amplitudes which follow from the general SU(3) and chiral SU(3) ⊗ SU(3) effective weak interactions are investigated. In particular it is found that the peculiar zero-energy limits obtained in the "current-algebra" approach are a consequence of SU(3) invariance for the current-current weak Hamiltonian wherein the symmetry breaking is thought to result from continuation of the external meson masses to their physical values. (auth)

44416 DYNAMICAL GROUP O(4,2) FOR BARYONS AND THE BEHAVIOR OF FORM FACTORS. Barut, A. O.; Kleinert, H. (Univ. of Colorado, Boulder). Phys. Rev., 161: 1464-6(Sept. 25, 1967).

The spectrum of observed baryon levels with the same internal quantum numbers and the behavior of the form factors lead to the hypothesis that the group O(4,2) is the dynamical group of the baryon levels with fixed internal quantum numbers. Indeed, the form factors in this theory have the correct anomalous singularity, as well as the double-pole behavior. The equality of $G_E(t)$ and $G_M(t)$ is discussed. (auth)

44417 BARYON MASS SPLITTINGS IN AN SU(6) x O(3) QUARK MODEL. Katyal, D. L. (National Physical Lab., New Delhi, Univ. of Delhi); Bhasin, V. S.; Mitra, A. N. Phys. Rev., 161: 1546-54(Sept. 25, 1967).

The positive- and negative-parity baryon mass shifts are investigated under the assumption that these particles belong, respectively, to the representations (56,1) and (70,3) of the group SU(6) × O(3), which are dynamically realizable from a 3-quark model with totally symmetric (S) functions, as found earlier by one of the authors. Two different types of SU(2)-invariant central forces $V^{(1)}$ and $V^{(2)}$, each of which is shown to be in conformity with the usual mass relations for the 56 states, are employed. One of these forces ($V^{(2)}$) is, however, found to violate the Gell-Mann–Okubo formula for certain negative-parity octets. It is also found that appreciable mixtures of both $V^{(1)}$ and $V^{(2)}$ are necessary even for a qualitative representation of the experimental masses. The effect of an SU(2)-invariant spin-orbit force of the type $\tau_1 \cdot \tau_2$ of modest strength (~25 MeV) is found to be very helpful in producing a reasonably good fit to the actual masses of the negative-parity baryons. Such a force has, however, no first-order effect on the 56 masses, on the assumption of orbital S functions, which can be constructed only with S-wave Q-Q pairs. The significance of this result is briefly discussed in connection with the question of quark statistics. (auth)

44418 SOME NEW IDEAS ON THE DYNAMICAL ORIGIN OF SYMMETRIES. Kursunoglu, Behram (Univ. of Miami, Fla.). pp 126-60 of Symmetry Principles and Fundamental Particles, Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

The question of validity of quantum electrodynamics at distances less than the classical electron radius is considered from the symmetry point of view. In this connection, symmetries of general relativistic group, and, in particular, nonlinear field theories and their linear forms are reconsidered in the light of latest developments and techniques of particle physics. An example is given of an exact symmetry originating entirely from the invariance of the gravitational field under general space-time transformation group. Electrodynamics and higher symmetries are treated, beginning with Maxwell's equations cast in a new form using generators of the group U(3). The appearance of SU(3,1) in electrodynamics is discussed, and modification for short distances is treated. (L.B.S.)

44419 WEAK INTERACTIONS AND CP VIOLATION. Glashow, Sheldon L. (Harvard Univ., Cambridge, Mass.). pp 350-90 of Symmetry Principles and Fundamental Particles, Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

A review is given on the theory of weak interactions with particular emphasis on those aspects which may be relevant to the understanding of CP violation. Selection rules are first discussed; the topics include: $\Delta Q = \pm 1$; $\Delta S \leq 1$; $\Delta S = \Delta Q$ for strangeness-violating decays; the SU(3) synthesis; the nonleptonic $\Delta I = \frac{1}{2}$ rule; dynamical octet enhancement; and difficulties with the tadpole model. The second section treats the violation of CP: experiments involving weak interactions; possible C violation in non-weak phenomena; weak interactions of CP; and the complex Cabibbo angle and PUC. (L.B.S.)

Applications (Strong)

Refer also to abstract 44350.

44420 MESON DECAY RATES IN O(4,2) AND THE INTRODUCTION OF SU(3). Barut, A. O.; Tripathy, K. C. (Univ. of Colorado, Boulder). Phys. Rev. Lett., 19: 918-21(Oct. 16, 1967).

The relativistic O(4,2) dynamics is applied in its simplified version to meson decays with spin parity $2^+ \to 1^- + 0^-$, $2^+ \to 0^- + 0^-$, $1^- \to 0^- + 0^-$ in good agreement with experiment. (auth)

44421 NEW TEST OF T INVARIANCE IN p–p SCATTERING. Handler, R.; Wright, S. C. (Univ. of Chicago). Phys. Rev. Lett., 19: 933-6(Oct. 16, 1967).

A test of T invariance in p–p triple scattering was performed at 430 MeV. The difference in two polarizations which are identical if T is valid was found to be 0.0006 ± 0.0028. The T-nonconserving amplitude was found to be less than ½% of the T-conserving amplitude. The T-nonconserving phase was found to be less than 0.06 of its maximum value. (auth)

44422 LIMITS ON $|\Delta T| = \frac{3}{2}, \frac{5}{2}$ AMPLITUDES AND CP NONINVARIANCE IN $K_{\pi 3}$ DECAY. Devlin, Thomas J. (Princeton Univ., N. J.); Barshay, Saul. Phys. Rev. Lett., 19: 881-4(Oct. 9, 1967).

To the extent that one considers significant a three-standard deviation effect in a concensus analysis of the experimental data on K decays, the conclusion can be drawn that one or both of the following statements hold. The first postulates that CP noninvariance occurs in the $K_{\pi 3}$ amplitude with $|\Delta T| = \frac{1}{2}$. The second states that there is a $K_{\pi 3}$ amplitude with $|\Delta T| = \frac{3}{2}$ in magnitude of the order of 4 to 20% of the $|\Delta T| = \frac{1}{2}$ amplitude, and this amplitude may have a CP-noninvariant part. The above statements are independent of the possible presence of a small $K_{\pi 3}$ amplitude with $|\Delta T| = \frac{5}{2}$, which the analysis severely limits in magnitude. (J.F.P.)

44423 STATISTICAL UNITARY–SYMMETRIC THEORY OF THE ANNIHILATION PROCESSES. Barashenkov, V. S.; Zinov'ev, G. M.; Maltsev, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 412-16(Aug. 1967). (In Russian).

A statistical model is proposed in which particles are considered as the members of the corresponding SU(3) multiplet. The results of calculations made for the $p\bar{p}$ annihilation are close to the experimental data. There is an essential disagreement only for the branching ratios of channels with a few number of particles. The calculations are considerably simplified as compared to the current model because the statistical weights of many channels appear to differ only by a constant factor ("unitary weight") which can be tabulated separately. (auth)

44424 NON-CONSERVATION OF CP-PARITY IN STRONG INTERACTIONS AND $\beta\gamma\gamma$ CORRELATIONS. Lobov, G. A. (Inst. of Theoretical and Experimental Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1114-17(July 1966). (In Russian).

The correlations of the directions of the successively emitted β-decay electron and 2γ quanta which follow after the β decay of the cascade were examined in an attempt to use these experimental $\beta\gamma\gamma$ correlations to verify the conservation of the CP parity in a strong interaction. The $\beta\gamma\gamma$ correlations are considered for the generalized case, assuming that both of the γ transitions are compound transitions. The effect of the dimensions of the nucleus and of the interaction of the electron with the Coulomb field of the nucleus in its final state on the $\beta\gamma\gamma$ correlation were also taken into account. The formula obtained was used to calculate the $\beta\gamma\gamma$ correlation for the ^{47}Ca, ^{106}Rh, and ^{56}Mn nuclei. Evaluation of the nonconservation of the CP parity was found to depend on the model used. The accuracy of present experimental measurements is not sufficient to draw conclusions concerning the agreement of theoretical values and experimental measurements. (TTT)

44425 MASS FORMULA FOR THE P-WAVE SUPERMULTIPLET OF THE HIGHER BOSON RESONANCES. Sartori, G. (Univ., Padua). Nuovo Cim. (10), 51A: 354-68(Sept. 21, 1967).

A relativistic model which describes the positive-parity higher boson resonances as a P-wave $q\text{-}\bar{q}$ system is discussed. In particular a mass formula is obtained which is in agreement with the available experimental results. (auth)

44426 VECTOR CURRENTS AND SPECTRAL-FUNCTION SUM RULES. Sakurai, J. J. (Univ. of Chicago). Phys. Rev. Lett., 19: 803-5(Oct. 2, 1967).

It is argued, on experimental grounds, that Weinberg's second sum rule must be abandoned for vector-current spectral functions as long as the vector-meson dominance approximation is qualitatively valid. (auth)

44427 BOOTSTRAP MODEL WITH HADRONS OF BOTH PARITIES. Capps, Richard H. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 161: 1538-45(Sept. 25, 1967).

A bootstrap condition, used commonly to study internal symmetries, is generalized so that it may be applied to states of different spins and parities. A bootstrap model of vector mesons and spin-½ baryons, developed by Cutkosky and Polkinghorne, is generalized to $SU(6)_w$ symmetry and to include mesons and bar-

yons of both parities. A solution is found involving odd- and even-parity mesons and even- and odd-parity baryons that correspond to the $SU(6)_w$ representations 35, $35 \oplus 1$, 56, and 70, respectively. The existence of the solution depends on certain exact properties of the $35 \otimes 56$ and $35 \otimes 35$ crossing matrices of SU(6). The physical interpretation of the solution is discussed; the odd-parity baryon multiplet corresponds physically to the $SU(6) \otimes O(3)$ representation (70, 3). (auth)

44428 THE HOMOGENEOUS LORENTZ GROUP AND πN CHARGE-EXCHANGE SCATTERING. Akyeampong, D. A.; Boyce, J. F.; Rashid, M. A. (IAEA, Trieste, Italy). Phys. Lett., 25B: 336-8(Sept. 18, 1967).

The partial wave expansion of the scattering amplitudes in terms of the homogeneous Lorentz group extended to $t \neq 0$ is studied with particular reference to the high-energy behavior of πN charge-exchange scattering. In order that the analysis accommodate all the nice features of Regge pole theory, it is necessary either that the ρ-meson trajectory should contain both $j_0 = 0$ and $j_0 = 1$ contributions (a j_0-mixing) or that there exist another trajectory ρ' with the same quantum numbers as ρ. (auth)

44429 CRITIQUE OF THE USE OF SYMMETRY PRINCIPLES IN STRONG INTERACTIONS. Fronsdal, Christian (Univ. of California, Los Angeles). pp 46-91 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Lectures are presented on practical methods for using symmetry principles in strong interactions, methods for constructing representations, and determining their properties. The first lecture is devoted to an application of a properly relativized form of SU(6). The following three lectures deal with representations of simple noncompact Lie groups in general. The results of Harish-Chandra on integrability of representations of Lie algebras are sketched, and an algebraic construction of all integrable representations is outlined. The groups SU(p,1) are treated in somewhat greater detail. The relation between the algebraic, infinitesimal approach and the analytic, global approach is explained by means of an example. The last lecture is concerned with the Majorana-Gel'fand-Yaglom theory of infinite-dimensional wave equations. (L.B.S.)

44430 DYNAMICAL GROUPS. Barut, Asim O. (Univ. of Colorado, Boulder). pp 92-125 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

An elementary review is given of the applications of noncompact dynamical groups to nonrelativistic and relativistic quantum theory. The mathematical formulation of dynamic groups, broken symmetry, calculation of phase shifts and scattering states, and extension of dynamic groups by discrete operation are first discussed. The role of the Poincare group is next considered for inclusion of the states of motion. The problem of finding out what operators of the dynamic group correspond to physical transition operators or currents is treated. Applications to strongly interacting particles are briefly outlined, for the explanation of mass spectrum and quantum numbers of all baryons and baryon resonances, and the explanation of the scattering of baryons. (L.B.S.)

44431 SUM RULES, HIGH ENERGY THEOREMS, AND SINGULAR COMMUTATORS IN THE ALGEBRA OF CURRENTS. Moffat, John W. (Univ. of Toronto). pp 317-49 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Some aspects of the current algebras as manifestations of the broken symmetry are discussed. The topics explored are: quark fields and the $U(3) \times U(3)$ and SU(6) algebras; the PCAC hypothesis; sum rules based on current algebras; high energy theorems based on the commutation relation for the quark pseudoscalar generator; and singular equal time commutators. (L.B.S.)

Quantum Field Theories

Refer also to abstracts 44251 and 44301.

44432 (JINR-E2-3498) RELATIVISTICALLY COVARIANT EQUATIONS FOR TWO PARTICLES IN QUANTUM FIELD THEORY. Matveev, V. A.; Muradyan, R. M.; Tavkhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 24p. Dep.

Relativistically covariant equations for description of the interaction of two particles (with spin 0 and $\frac{1}{2}$) in quantum field theory are proposed. The connection with the quasipotential approach is discussed. (auth)

44433 PARASTATISTICS: ANALYSIS AND IRREDUCIBLE REPRESENTATIONS OF PARA FIELDS. Galindo, A. (Facultad de Ciencias, Zaragoza, Spain). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 299-305(Sept.-Oct. 1967). (In Spanish).

A general representation of para-fields is given and in particular of those of rank 2. Their structure and irreducibility properties are then derived and finally the important question of indistinguishability is dealt with. (auth)

44434 NEW SOLUTIONS OF THE THIRRING MODEL. Hagen, C. R. (Interantional Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 51B: 169-86(Sept. 11, 1967).

The device of the external source is used to evaluate the Green's functions of the Thirring model. The essential departure from earlier approaches to this problem consists in the use of a generalization of Schwinger's definition of the current operator for the case in which there exists a coupling to an external field. It is found that this definition does not determine uniquely the current operator and that the solution consequently contains a free parameter which does not explicitly appear in the original Lagrangian. Although the solution reduces to that obtained by Johnson for a particular value of this parameter, the present approach has the distinct advantage of avoiding timelike limits in the definition of the current as well as clearly indicating the existence of a more general class of solutions than has previously been known. The energy-momentum tensor is displayed explicitly and is shown by direct calculation to satisfy Schwinger's commutator condition on the energy density. (auth)

44435 ON PRACTICAL CONCLUSIONS STEMMING FROM THE NOTION OF THE BORCHERS CLASS. Garczynski, W.; Sznajder, N. (Univ., Wroclaw). Postepy Fiz., 18: 425-34 (1967). (In Polish).

The practical usefulness of the notion of the Borchers class of local fields is considered. There is given proof of the physical equivalency of fields belonging to the same Borchers class, which allows reducing the number of fields describing the interacting elementary particles to the bare minimum of nonequivalent fields. This elimination is illustrated by a concrete example. Also discussed is the phenomenon of the uniqueness of the local solutions to the inhomogeneous Klein-Gordon equation and the structure of the Borchers class of a free field is described. (auth)

44436 REGGEON DIAGRAM TECHNIQUE. Gribov, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz., 53: 654-72(Aug. 1967). (In Russian).

A diagram technique for analysis of branch points in the angular momenta complex plane is formulated on basis of a study of the asymptotic behavior of the Feynman diagrams for high energies and a fixed momentum transfer. In this method the reggeon is considered as a nonrelativistic particle characterized by a two-dimensional momentum k. The pole trajectory $a(k^2)$ plays the role of energy and the angular momentum j the role of frequency. The situation which arises when the diffraction cone is described under the assumption of the existence of a Pomeranchuk pole is discussed. (auth)

44437 STRESS-TENSOR COMMUTATORS AND SCHWINGER TERMS. Boulware, David G. (Univ. of Washington, Seattle); Deser, S. J. Math. Phys. (N. Y.), 8: 1468-77(July 1967).

General properties of commutators involving Poincaré generators or stress-tensor components, particularly those of local commutators among the latter are investigated in local field theory. The spectral representation of the vacuum stress commutator is given, and shown to require the existence of singular "Schwinger terms" at equal times, similar to those present in current commutators. These terms are analyzed and related to the metric dependence of the stress tensor in the presence of a prescribed gravitational field and some general results concerning this dependence presented. The resolution of the Schwinger paradox for the $T^{\mu\nu}$ commutators is discussed together with some of its implications, such as "nonclassical" metric dependence of $T^{\mu\nu}$. A further paradox concerning the vacuum self-stress—whether the stress tensor or its vacuum-subtracted value should enter in the commutators—is related to the covariance of the theory, and partially resolved within this framework. (auth)

44438 SPIN-3/2 FIELDS AND POSITIVE DEFINITE ENERGY. Horwitz, L. P.; Mohan, G. (Univ. of Denver). Nuovo Cim. (10), 51A: 542-50(Sept. 21, 1967).

It is shown that the parity operator which is also the metric, is a mixture of zero components of a third-rank tensor and a first-rank tensor. The covariant equation guaranteeing definite parity thus becomes a subsidiary third-order differential equation. Another formulation for a spin-$\frac{3}{2}$ field which obtains positive definite energy and does not need a subsidiary equation is pointed

out. Generators of the Poincare group are constructed explicitly. It is found that certain terms which are called "tensor polarization" of the Lorentz generators are separately conserved. (J.F.P.)

44439 INEQUIVALENCE OF $\Phi_c = \Phi$ AND $Z_3 = 0$. Brandt, R. A.; Sucher, J.; Woo, C. H. (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 801-3(Oct. 2, 1967).

It is pointed out that the vanishing of the wave-function renormalization constant associated with a field operator Φ is not implied by the existence of a representation of Φ as a weak limit of a nonlocal product of other fields. (auth)

44440 QUANTIZATION OF MULTISPINOR FIELDS. Chang, Shau-jin (Harvard Univ., Cambridge, Mass.). Contract AF 49(638)-1380. Phys. Rev., 161: 1316-26(Sept. 25, 1967).

The multispinor fields which describe massive fields with spin ≤ 2 are constructed. These fields are quantized using Schwinger's action principle. Lorentz invariance and physical positive-definiteness requirements are verified. In particular, those fields with spins 0, 1, and $\frac{1}{2}$ are explored in detail. It is shown that the spin-$\frac{1}{2}$ system described by a third-rank multispinor is not equivalent to the Dirac field in the presence of electromagnetic interaction. It describes a spin-$\frac{1}{2}$ system without intrinsic magnetic moment. The Lorentz invariance of the interacting system is verified. This result will facilitate the physical explanation of the famous $\frac{2}{3}$ ratio of the nucleon magnetic moments. (auth)

44441 LAGRANGE FORMULATION FOR SYSTEMS WITH HIGHER SPIN. Chang, Shau-jin (Harvard Univ., Cambridge, Mass.). Phys. Rev., 161: 1308-15(Sept. 25, 1967).

Prescriptions for constructing the generalized Lagrange function for a system with an arbitrary spin S are presented. By the use of the spin projection operators introduced by Fronsdal, nonlocal field equations are constructed to describe these higher-spin systems. Then, auxiliary fields are introduced systematically to remove the nonlocalities appearing in these field equations. Lagrange functions describing systems with $S \leq 4$ are constructed explicitly according to this new prescription. For $S = 0, \frac{1}{2}, 1$, they agree with the well-known local Lagrange functions. For $S = \frac{3}{2}$ and 2, they are equivalent to the results previously obtained by Rarita and Schwinger, and and by Fierz and Pauli. With the help of the quantum action principle, canonical quantizations are carried out and Green's functions are constructed. Some physical positiveness requirements are also verified. (auth)

44442 CONSISTENCY CONDITIONS FOR WAVE FUNCTIONS SATISFYING DIRAC OR KEMMER EQUATIONS. Loh, Hooi-tong; Daykin, D. E. (Univ. of Malaya, Kuala Lumpur, Malaysia). Phys. Rev., 161: 1326-7(Sept. 25, 1967).

For both the Dirac and the spin-zero Kemmer equations, conditions on the wave function for the existence of real solutions for the field potentials are obtained. Also the field variables are expressed in terms of the wave function for the Kemmer equations. (auth)

44443 APPLICATIONS OF THE DIRAC–SCHWINGER COVARIANCE CONDITION IN QUANTUM ELECTRODYNAMICS. Brown, Stanley G. (Univ. of Pennsylvania, Philadelphia. Cornell Univ., Ithaca, N. Y.); Bludman, Sidney A. Phys. Rev., 161: 1505-12(Sept. 25, 1967).

The Dirac-Schwinger condition, which relates the equal-time commutator of the energy density to the momentum density, assures covariance of quantum field theories. Two different applications of this condition are presented: (1) In the Lee-Yang vector electrodynamics (without ξ limiting), for an anomalous magnetic moment κ, ambiguous extra terms involving $\partial\delta^3(0)$ appear in order κ^4 and higher; this is associated with the fact that this theory is outside a preferred subclass of theories identified in previous work. An alternative theory of anomalous-moment electrodynamics is formulated which is in the subclass and hence free of these ambiguities and which therefore yields a manifestly covariant S matrix. (2) In spinor electrodynamics with a Pauli moment, the Dirac-Schwinger condition is satisfied, but the equations of motion appear not to be covariant. This is related to the singular nature of the double commutator involved in the testing of the covariance of the equations of motion and to the ambiguity of $(x_i - x_i')\delta^3(x - x')$ when multiplying operators. (auth)

44444 INTRODUCTION TO CURRENT ALGEBRA. Fubini, Sergio (Univ., Turin). pp 279-316 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

Two approaches are considered for overcoming the difficulties involved in obtaining relativistic invariance of the equal time commutation relations between the charges or the charge densities. The first approach exploits the implicit invariance of the whole scheme in order to choose a special frame of reference–the infinite momentum frame. The second method makes explicit use of microcausality and gives a general expression to the matrix elements of the commutators by means of dispersion theory. (L.B.S.)

Scattering Theory

44445 (BNL–11700) ANALYTIC PROPERTIES OF SCATTERING AMPLITUDES FROM FIELD THEORY AND UNITARITY. Martin, Andre (European Organization for Nuclear Research, Geneva (Switzerland). Brookhaven National Lab., Upton, N. Y.). Aug. 1967. 9p. (CONF-670820–1). Dep. CFSTI.

From High Energy Conference, Rochester, N. Y.

The question of the analyticity domain of scattering amplitudes from field theory and unitarity is discussed. Examples are given of physical results obtained from analyticity. The existing information derived from positivity, elastic unitarity in the elastic region and crossing is summarized. A theorem by Epstein and Glaser for extending the analyticity domain is briefly discussed, and main results are outlined. Counter-examples and dispersion relations are constructed, which are consistent with results of elastic unitarity. (L.B.S.)

44446 GHOST-ELIMINATING ZEROS IN THE REGGE-POLE MODEL. Matsuda, Satoshi; Igi, Keiji (Tokyo Univ.). Phys. Rev. Lett., 19: 928-33(Oct. 16, 1967).

The superconvergent sum rules for helicity-flip and -nonflip amplitudes controlled by only the R trajectory are used to clarify the ghost-eliminating mechanisms. (auth)

44447 ENHANCEMENT FACTORS FOR POTENTIALS WITH EXPONENTIAL TAIL. Guardiola, R.; Pascual, P. (Facultad de Ciencias, Valencia). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 279-83(Sept.-Oct. 1967).

Results are given which are useful for finding an exponential-like potential which describes the low-energy data for the two-particle system. Although it is known that the low-energy data of the n–d potential cannot be fit with any reasonable square well potentials, it is found that it can be described by a physical exponential well. The Jost function is used in this calculation. (J.F.P.)

44448 ENERGY DEPENDENCE OF SCATTERING CROSS SECTION NEAR THE THRESHOLD OF THREE-BODY REACTIONS. Lazarev, L. M. Yadern. Fiz., 6: 416-20(Aug. 1967). (In Russian).

The cross section of elastic scattering is shown to have a singularity near the three-particle threshold. The investigation of this singularity makes it possible to deduce spins and parities of the particles created in the reaction, to find the reaction cross section, and to carry out the phase shift analysis above the threshold. (auth)

44449 ELASTIC SCATTERING IN THE QUARK MODEL. Boehm, Manfred (Univ., Wuerzburg, Ger.). Z. Phys., 206: 219-22(1967). (In German).

Certain predictions from the quark model for elastic scattering amplitudes are tested using experimental values of the elastic cross sections at low momentum transfers. (auth)

44450 RENORMALIZED COUPLING CONSTANTS AND THE INVERSION PROBLEM. Fonda, Luciano; Ghirardi, Gian Carlo (Univ., Trieste, Italy). J. Math. Phys. (N. Y.), 8: 1312-14 (June 1967).

It is shown how, starting from the (experimental) knowledge of scattering phase shift, energies of bound states and renormalized coupling constants, one is able to determine completely the parameters of a quantum field theoretic model previously considered, the so-called Dyson model. The very same conclusion holds for the case of potential scattering, which is also briefly considered. (auth)

44451 UPPER BOUNDS TO EIGENVALUES OF THE ONE-DIMENSIONAL STURM–LIOUVILLE EQUATION. Nordtvedt, K. Jr. (Montana State Univ., Bozeman). J. Math. Phys. (N. Y.), 8: 1406-9(July 1967).

This work develops a straightforward technique for giving an upper bound to any eigenvalue of the one dimensional Sturm–Liouville problem. It is shown that any trial function that fulfills the proper boundary condition of the problem and possesses the same number of nodes as an exact eigenfunction of the problem can provide an upper bound to that eigenfunction's eigenvalue. Application of the above technique is made to provide a one-sided bound to quantum mechanical scattering phase shifts. (auth)

44452 RESCATTERING EFFECTS IN THREE-PARTICLE FINAL STATES. I. THE MODEL. Aitchison, I. J. R. (Ca-

vendish Lab., Cambridge, Eng.). Nuovo Cim. (10), 51A: 249-71(Sept. 21, 1967).

The Khuri-Treiman representation is used to set up linear, single-variable, integral equations for the amplitudes describing final-state interactions among three particles. Their relation to other (potential and S-matrix) theories is discussed, and the physical interpretation of the iteration solution as a rescattering expansion, in which the usual isobar approximation is the first term, is elaborated on. The qualitative nature of the rescattering corrections is discussed, in terms of both one- and two-dimensional final-state distributions. Numerical difficulties arising from the singularities of the kernel are pointed out. (auth)

44453 RESCATTERING EFFECTS IN THREE-PARTICLE FINAL STATES. II. NUMERICAL RESULTS. Aitchison, I. J. R. (Cavendish Lab., Cambridge, Eng.). Nuovo Cim. (10), 51A: 272-88(Sept. 21, 1967).

Solutions are presented to the equations, set up previously, describing final-state interactions among three particles in the zero-range approximation. The following possible effects appear: shifts in position, and changes in width, of a two-body resonance due to resonant interactions of one or other of its constituents with the third particle; the simulation, in certain circumstances, of an anomalously large scattering length due to parallel resonance formation; "pseudo-resonance" due to logarithmic singularities, which may appear on the Dalitz plot but not in projections. The first of these may be relevant to the various reported masses and widths of the ρ meson; the second to the ABC effect, and, less probably, to the Kirz, Schwarz and Tripp anomaly; the third appears very unlikely to be able to account for any such large-scale effects as the $K\bar{K}$ enhancement observed by Armenteros et al. (auth)

44454 GROUP-THEORETICAL INTERPRETATION OF COMPLEX ANGULAR MOMENTUM. Iverson, G. J. (Univ. of Adelaide). Nuovo Cim. (10), 51A: 289-304(Sept. 21, 1967).

Group properties of complex angular momentum are investigated from the point of view of the Schrödinger equation and representation theory of the complex orthogonal group $O_{3,C}$ and its subgroups. Analytic functions corresponding to arbitrary values of l are constructed on the complex sphere; these functions carry irreducible representations of a subgroup $L \subset O_{3,C}$. An expansion formula for analytic functions defined on the complex sphere is derived in the form of a Sommerfeld-Watson transform. The method is nonrelativistic throughout, and explains the apparent crossing behavior of the amplitude within a nonrelativistic context. (auth)

44455 ANALYTIC CONTINUATION OF THE FROISSART-GRIBOV PARTIAL-WAVE AMPLITUDE TO THE LEFT-HALF l PLANE. Roy, S. M. (Univ. of California, San Diego, La Jolla). Contract AT(11-1)-Gen-10. Phys. Rev., 161: 1575-80(Sept. 25, 1967). (UCSD-10P10-16).

A continuation of the Froissart-Gribov definition of the partial-wave amplitude to the left of the poles in the l plane is obtained under the assumption of power-law behaviors of the Mandelstam weight functions at high energy. Discrete and continuous powers in these weight functions are seen to yield, respectively, poles and cuts in the continued partial-wave amplitude. This continuation is then used to prove that in the presence of cuts a generalized form of the Mandelstam symmetry relation for the partial-wave amplitudes about $l = -\frac{1}{2}$ for the half-odd-integral values of l holds at energies where there are no Regge poles passing through half-odd integers. The discontinuity across the cut at a half-odd integer is always equal to discontinuity across the cut at the half odd integer obtained by reflection about $l = -\frac{1}{2}$. The case of Regge poles passing through half-odd integers is considered in detail, and the results derived by Mandelstam for potential scattering are shown to follow from our continuation in a straightforward manner. The continued partial-wave amplitude has the desirable feature that every term in it has the correct threshold behavior, $(q^2)^l$. (auth)

44456 REGGE POLES WITH RELATIVISTIC KINEMATICS. Ahmadzadeh, Akbar (Arizona State Univ., Tempe); Chung, Victor. Contract AT(11-1)-Gen-10. Phys. Rev., 161: 1602-6 (Sept. 25, 1967). (UCSD-10P10-27).

The partial-wave amplitude in the Blankenbecler-Sugar approximation to the Bethe-Salpeter equation is computed numerically using two different methods. One method applies the Noyes-Kowalski trick of reducing the integral equation to one with a nonsingular kernel. A somewhat simpler method reduces the singular integral equation to a finite matrix equation without rewriting the equation in a nonsingular form. Both methods are used to calculate the partial-wave amplitude and Regge trajectories for a Yukawa potential. (auth)

44457 CONNECTION BETWEEN REGGE-POLE AND SINGLE-PARTICLE EXCHANGE MODELS FOR HIGH-ENERGY REACTIONS. Durand III, Loyal (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 161: 1610-11(Sept. 25, 1967). (COO-881-99).

It is shown that the $s^{\alpha(0)}$ energy dependence of high-energy transition amplitudes characteristic of the Regge-pole model can be obtained directly in the s channel by summing the most divergent terms resulting from an infinite set of single-particle exchanges in the t channel. (auth)

44458 COMPLEX ANGULAR MOMENTUM AND INFINITE HELICITY SUMS. Drummond, Ian T.; Winbow, G. A. (Cambridge Univ., Eng.). Phys. Rev., 161: 1401-10(Sept. 25, 1967).

Previous discussions of the continuation to complex angular momentum of three-particle unitarity integrals for simple diagrams are reformulated in terms of infinite helicity sums. This is achieved by a redefinition of the partial-wave projection of the production amplitudes. It is found that the helicity sums can be made to converge by suitable choice of complex contours for the phase-space integral. It is shown that this leads to the same results as found previously without the introduction of helicity sums. (auth)

44459 ANALYTIC S-MATRIX APPROACH TO ZERO-MOMENTUM-TRANSFER SYMMETRY. Ball, N. F. (Univ. of California, Berkeley); Ball, James S.; Chew, Geoffrey F.; Pignotti, Alberto. Contract W-7405-eng-48. Phys. Rev., 161: 1459-63(Sept. 25, 1967). (UCRL-17491).

By an explicit mapping procedure, a meaning is given to approximate zero-momentum-transfer symmetry for analytic S-matrix elements containing a sufficiently large number of particles. The difficulty in formulating the symmetry for 2-particle-to-2-particle reactions is elucidated. (auth)

44460 NON-FADDEEV EQUATION FOR THREE-BODY BOUND STATES, WITHOUT SPURIOUS SOLUTIONS. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 161: 1495-7(Sept. 25, 1967).

It is shown that in addition to the Faddeev equations, there is at least one other formulation of the quantum-mechanical three-body problem which does not possess spurious homogeneous solutions of the type reported by Federbush. This result settles the question of the uniqueness of the Faddeev equations. (auth)

44461 STRUCTURE OF UNITARY SCATTERING AMPLITUDES. Martin, Arthur W. (Stanford Univ., Calif.). Contract AF 49(638)-1389. Phys. Rev., 161: 1528-37(Sept. 25, 1967).

A representation for the scattering amplitude A(s,t,u) is developed that satisfies elastic unitarity in the s channel. The representation has the structure of the Mandelstam representation so it can be analytically continued to the crossed channels to impose the constraints of crossing symmetry. The development utilizes the flexibility of the N/D representation for unitary partial-wave amplitudes and summation techniques for a class of Legendre sums to construct the unitary amplitude. Methods for incorporating inelastic unitarity and difficulties with crossing symmetry are discussed. (auth)

44462 UNITARY PADE APPROXIMANTS FOR THE S MATRIX IN STRONG COUPLING FIELD THEORY AND APPLICATION TO THE CALCULATION OF THE ρ AND f_0 REGGE TRAJECTORIES. Bessis, D.; Pusterla, M. (CERN, Geneva). Phys. Lett., 25B: 279-81(Sept. 4, 1967).

A method is presented for obtaining nonperturbative solutions of the field theoretic S matrix, such that for very small values of the coupling they reproduce the perturbative expansion, by considering the S matrix as the limit of the [N,M] sequence of Padé approximants. The method is applied to the calculation of the Regge trajectories of the ρ and the f^0 mesons. (L.B.S.)

44463 SATISFYING THRESHOLD CONDITIONS ON PARTIAL WAVE AMPLITUDES. Auvil, P. R. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 25B: 276-7(Sept. 4, 1967).

It is shown that the technique of satisfying correct threshold behavior in partial wave amplitudes by using a multiplicative phase-space factor is completely equivalent to the method of adding background forces to the left-hand cut. This correspondence allows a physical interpretation of the poles of the phase-space factor used. (auth)

44464 TWO SURVEY SEMINARS ON RECENT DEVELOPMENTS IN S-MATRIX THEORY. Olive, David I. (Cambridge Univ., Eng.). pp 514-32 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

An outline is given of the basic assumptions used recently to

obtain the connection between spin and statistics in S-matrix theory. Brief discussions are given on connectedness, unitarity, Hermitian analyticity, statistics, antiparticles, crossing, and generalizations. The second section treats Landau singularities, Cutosky formulas, singularities of unitarity integrals, pole singularity, the triangle singularity, properties of unitarity integrals, and comparison of unitarity argument. (L.B.S.)

Particle Accelerators

Refer also to abstracts 43092, 43108, 43109, 43814, 44146, 44509–44514, 44516, 44517, and 44597.

44465 (AD–651569) A PULSED-BEAM FACILITY FOR THE UNIVERSITY OF ROCHESTER'S MP TANDEM. Purser, K. H.; Bahnsen, A.; Krick, M. S. (Rochester Univ., N. Y. Nuclear Structure Research Lab.). Feb. 1967. Contract AF49-(638)-1707. 108p. (UR-NSRL-2; AFOSR-67-0989). CFSTI.

A pulsed-beam system is being planned which will provide pulsed beams of heavy ions, protons, deuterons, and ^{3}He. The following topics are covered with respect to such a facility: design considerations; fundamentals of pulsing; effect of pulsing on tandem optics; post-acceleration beam transport; and specific parameters for Rochester MP. (auth)

44466 (BNL–11719) PERTURBATIONS AND TOLERANCES IN A 200-MeV PROTON LINAC. Parzen, G. (Brookhaven National Lab., Upton, N. Y.). [1967]. 14p. (CONF-670930–2). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

Results for the frequency shift and power losses due to the stems, and for the shift in frequency due to changes of the cell diameter, the cell gap, the drift tube curvature, the cell length, the drift tube diameter, and the drift tube bore diameter in a 200-MeV proton linear accelerator are presented. The tolerances on the parameters due to a shift in the resonant frequency are also presented. (W.H.K.)

44467 (BNL–11761) SUPERCONDUCTING SYNCHROTRON MAGNETS. Sampson, W. B.; Britton, R. B.; Morgan, G. H.; Dahl, P. F. (Brookhaven National Lab., Upton, N. Y.). [1966]. 11p. (CONF-670930–3). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

The feasibility of using high-field pulsed superconducting magnets for proton synchrotrons is investigated. A study of the power losses resulting from pulsed operation of superconducting synchrotron-type magnets is presented. (W.H.K.)

44468 (BNL–11765) EFFECTIVE TRANSVERSE PHASE SPACE DILUTION AND BEAM DENSITY DISTRIBUTION IN THE AGS. van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). [1967]. 12p. (CONF-670930–4). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

A study to investigate beam-intensity loss with the multiple-turn injection system of the Alternating-Gradient Synchrotron is presented. The emittance in the synchrotron is obtained by using the kicker unit of the fast external beam system and channeling the low-energy beam into a short extraction channel immediately following the fast kicker, and subsequently measuring the beam density distributions with a scanning-slit wire-target combination. The relation of emittance behavior to beam intensity, the effective phase space dilution, and the phase space density distribution are investigated. (W.H.K.)

44469 (BNL–11767) THE NATURE OF THE TRANSVERSE INSTABILITY IN THE BROOKHAVEN AGS. Raka, E. C. (Brookhaven National Lab., Upton, N. Y.). [1967]. 8p. (CONF-670930–5). Dep. CFSTI.

From 6th International Conference on High Energy Accelerators, Cambridge, Mass.

An investigation of the resistive wall instability in the Brookhaven Alternating-Gradient Synchrotron is discussed. The instability is found when the synchrotron is under poor vacuum or when the synchrotron is flat topped at low energy. (W.H.K.)

44470 (N-67-21179) IMPROVED SULFUR HEXAFLUORIDE GAS HANDLING SYSTEM FOR A POTENTIAL DROP PARTICLE ACCELERATOR. Marsik, S. J.; Stevenson, F. R.; Deraimo, J. C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). 1967. 7p. (NASA-TM-X-52274). CFSTI.

An improved sulfur hexafluoride (SF_6) gas handling system was designed and built for a 3.0 MeV accelerator utilizing the original components provided with the accelerator. The purpose of the system is to remove the gas from the accelerator when opening is necessary, purify and store it, and return it to the vessel. The advantages are reduction in cycle time from 7 hours to about 3 hours, reduction in unretrieved gas from 7% to as little as 0.02%, compactness and improved purification resulting from liquefaction and additional filtering, and safe, reliable semi-automatic operation. Design considerations, fabrication techniques, and performance evaluation of the system are given. (auth) (STAR)

44471 (NIRL–M–82) RADIATION MEASUREMENTS AROUND THE NIMROD 7 GeV EXTRACTED BEAM. Shaw, K. B.; Laws, D.; Perry, D. R. (National Inst. for Research in Nuclear Science, Chilton (England). Rutherford High Energy Lab.). Mar. 1965. 18p. Dep.

Measurements on the secondary radiations produced by 7-GeV protons stopped in iron are presented. The detectors used were: aluminium, sulphur, gold, wax moderated foils, a moderated BF_3 counter and nuclear track films. (auth)

44472 (NP–17010) KASKADNYI AVTOGENERATOR. (Cascade Autooscillator). Sidorenko, I. S. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 30p. (In Russian). Dep.

Accelerators consisting of a single resonator are usually supplied by self-induced generators, while those provided with several resonators are supplied by generators with an independent excitation. At a frequency close to the eigenfrequency, stable oscillations may be created in the resonator. The frequency of the autogenerator may be stabilized by including resonator in the feedback circuit. The frequency and stability of autogenerators were examined to determine whether it is possible to control operational characteristics by the load within a given small power range. It was found that this may be achieved by means of a multicascade autogenerator consisting of 3 to 4 stable amplifying cascades and a selective, high-quality load system in the feedback circuit of the cascades. A spiral-shaped coaxial resonator, with a quality factor Q = 2000 and an eigenfrequency f_0 = 20 Mhz was used as the load. The eigenfrequency of the resonator was reduced by inserting a brass rod into the axial cavity. If the dependence of the resonance eigenfrequency on external factors is known, the data obtained makes it possible to select the corrent transmission band for the amplifier cascade circuits and to ensure thereby the continuity of oscillations thoughout the whole range of potential frequency changes of the load. (TTT)

44473 (UCID–15156) PULSER FOR ACCELERATOR CATHODE. Kuenning, R. W.; Winter, S. D. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 25, 1967. Contract W-7405-eng-48. 23p. Dep. CFSTI.

The design of a high-speed cathode pulser for the injector for a linear accelerator is discussed. Included topics are choice of tubes, damage prevention, avalanche transistor stage, interstage transformer, transformer core reset, shunt peaking and overdrive, time response calculation, and possible circuit improvements. (W.H.K.)

44474 (UCRL–17675) NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON. McKee, J. S. C. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 9, 1967. Contract W-7405-eng-48. 5p. Dep. CFSTI.

Design of a neutron source for polarization and cross section experiments on the neutron–deuteron system is briefly discussed. The source produces polarized neutrons from the ^{2}H(d,n)^{3}He reaction with Q = 3.266 MeV, and is intended for use with cyclotron beams of 10-MeV energy and upwards. (W.H.K.)

44475 (UJV–1825) EXTERNI IONTOVY ZDROJ PRO CYKLOTRON U-120 S DVOJITOU VYMENOU NABOJU. (External Ion Source for U-120 Cyclotron with Double Charge Exchange). Bejsovec, V.; Karban, O. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 20p. (In Czech). Dep.

An external ion source with double-charge exchange for the cyclotron U-120 was built and tested under laboratory conditions. Both neutralization and ionization coefficients were measured as functions of beam energy. The maximum efficiency of the injector was 5 and 9% with and without the magnetic field in the neutralization chamber respectively. (auth)

44476 (UJV–1848) ACCELERATION OF PROTONS IN THE U-120 CYCLOTRON. Dobias, J.; Fukatko, T.; Hrda, A.; Karban, O.; Krivanek, M.; Kult, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 7p. Dep.

Proton acceleration up to 10.7 MeV in the classic U-120 cyclotron of the Nuclear Research Institute at Řež is discussed. The magnetic field gradient was adjusted by means of disc and ring shims. The energy of the extracted proton beam was measured

after scattering on a gold target, using semiconductor detectors with total error ±30 keV. (auth)

44477 (UJV–1850) MAGNETIC CHARACTERISTICS OF A QUADRUPOLE LENS. Karmasin, M.; Spalek, V. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Aug. 1967. 15p. Dep.

Magnetic characteristics of quadrupole lenses designed for focusing a 13.5-MeV deuteron beam extracted from a U-120 cyclotron are discussed. Also, the effective length of the lenses was determined. (auth)

44478 MEASUREMENT OF THE Q FACTOR AND THE SHUNT RESISTANCE OF RESONANT DECELERATING SYSTEMS BY A COMBINATION PROBE METHOD. Gos'kov, P. I. Zh. Tekh. Fiz., 37: 971-6(May 1967). (In Russian).

A simplified method is proposed for simultaneously measuring the Q factor, the coupling resistance, and the shunt resistance of a resonant decelerating system such as is employed in connection with particle accelerators. To employ the proposed method one measures the resonant frequency of the cavity and the relative electric field strength within it before and after introduction of a special combination dielectric probe, and calculates the desired quantities from the measured resonant frequency shift and electric field strength ratio. The special combination probe is to be fabricated of two different dielectrics, one of which has a high loss tangent in order to give rise to a significant change of the Q factor, and the other of which has a high dielectric constant in order appreciably to shift the resonant frequency. The theory of the method is developed and factors affecting its accuracy are discussed. The simplicity of the method favors its automation, and the method should facilitate the many measurements on a large number of different types of decelerating system that are required for the intelligent selection of the decelerating system that most nearly meets the somewhat contradictory requirements that are imposed on a decelerating system by its use in connection with a waveguide synchrotron. The Q factor (about 1600) and the shunt resistance (about 11 kilohm/cm) of a decelerating system were measured by the present method and by two different conventional techniques, and the results are presented. The results given by the three different methods did not differ by more than the experimental error. (ATD)

44479 ENERGY GAIN OF OSCILLATOR IN FIELD OF STANDING WAVE NEAR CYCLOTRON RESONANCE. Krasovitskii, V. B. At. Energ. (USSR), 22: 423-8(June 1967). (In Russian).

The interaction of charged particles with the field of a standing wave with six phases in the presence of a constant magnetic field was examined for the cases where the wave frequencies ω is less than the cyclotron frequency ω_H. The frequency range $1 - \omega_H/\omega < (eE_0/mc\omega)^{\frac{1}{3}}$ was examined where the theoretical gradients are not applicable. It was shown that in this frequency range the motion of the particles is unstable. The growth increments of the longitudinal-transverse oscillations and the maximum longitudinal and transverse energies acquired by the particles were determined. The interaction of the oscillator with the electromagnetic field was investigated and the gain of the standing wave with random phases was presented. It was shown that in this case the particles can acquire energies significantly larger than in wave fields in fixed phases. (tr-auth)

44480 INFLUENCE OF THE FREQUENCY SPREAD ON THE STABILITY OF COHERENT OSCILLATIONS IN ACCELERATORS. Balbekov, V. I. At. Energ. (USSR), 22: 495-7(June 1967). (In Russian).

The coherent beam instability arises under the influence of currents induced in the walls of the vacuum chamber. Because of losses, these currents are shifted out of phase with respect to the beam current, creating transversal oscillations; the instability may be suppressed because of the frequency spread. It was therefore attempted to derive a generalized stability criterion for an arbitrary distribution function. In the calculations, assumptions were made concerning the dependence of the charge density on time and azimuth. The calculations indicated that in order to reach stability, the beam must possess an intensive component, the eigenfrequency of which equals the wave frequency; thus resonance interaction will result in the extinction of the oscillation. If the spread is large, the system is stable because noncoherent oscillations are created. The equations obtained were applied to a practical case involving the 70 BeV synchrotron; the results indicated that 3×10^{11} particles are present in the chamber at the time of injection, although the static limit is 10^{12} particles. (TTT)

44481 COHERENT TRANSVERSAL OSCILLATIONS OF THE PARTICLE BEAM IN ACCELERATORS WITH AUTOMATIC CORRECTION. Zhil'kov, E. A. At. Energ. (USSR), 22: 497-8(June 1967). (In Russian).

The kinetic equation was used for studying the stabilization of coherent transversal oscillations by means of an automatic control system. The distribution function which satisfies the kinetic equation relating to the coordinates and velocities of the particles in the longitudinal and transversal directions, the frequency of the linear betatron oscillations in the absence of an automatic control, their nonlinearity and corrective action by the control system, was used to analyze the various instabilities. The derived equations were used to calculate the stability of a monoenergetic beam, moving with a certain longitudinal velocity for slightly nonlinear betatron oscillations. The correction of the resistance instability for the limiting frequency of 350 kHz was examined; it was found that the automatic control system causes the extinction of the unstable oscillations at 200 kHz. Transversal oscillations at 400 kHz were also found to be stable. (TTT)

44482 THE CERN INTERSECTING STORAGE RINGS. Pentz, Michael J. (CERN, Geneva). Endeavour, 26: 126-8(Sept. 1967).

Despite the attention devoted to it in recent years, the nature of the strong interactions that occur between the particles inside an atomic nucleus is not understood. The investigation of these subnuclear forces demands increasingly powerful machines to produce and investigate collisions between these particles, and such machines are extremely expensive and difficult to build. The CERN intersecting storage rings, a device that ingeniously uses the particles from a proton accelerator to produce collisions with energies much higher than is normally possible is described. (auth) (UK)

44483 AUTOMATIC ION-BEAM PATH STABILIZER. Evans, Albert E.; Johnson, Kent (Naval Ordnance Lab., Silver Spring, Md.). Rev. Sci. Instrum., 38: 1514-16(Oct. 1967).

A system was built to correct the output of an ion accelerator for beam-path variations. Fringing current detected on collimating slits is used to adjust voltage levels on two sets of electrostatic-deflection plates which guide the beam. Design details and method of operation are described. (auth)

44484 TECHNIQUE FOR THE GENERATION OF QUASI-ISOTROPIC 1 TO 10 keV PROTON FLUXES. Bernstein, W.; Sanders, N. L.; Wax, R. L. (TRW Systems, Inc., Redondo Beach, Calif.). Contract NASW-1474. Rev. Sci. Instrum., 38: 1537-8(Oct. 1967).

A technique for generating quasi-isotropic 1- to 10-keV proton fluxes for calibrating instrumental resolution and geometrical factor is described. A pencil beam of mono-energetic protons is impinged on a carbon foil placed at the entrance of a detector and generates a quasi-isotropic flux of particles simulating the conditions under which the instruments are employed. (W.H.K.)

44485 PRODUCTION OF SUBMICROSECOND ION PULSES. Cheon, Beonguk; Kotani, Koichi; Akimune, Hideo; Suita, Tokuo (Osaka Univ.). Rev. Sci. Instrum., 38: 1471-6(Oct. 1967).

A hot cathode ion source was developed to produce pulsed ion beams. The source has a canal electrode whose characteristics resemble those of the grid of a vacuum triode. The characteristics are attributed to sheath formation in the canal. The ratio of the maximum current to the minimum is about 10^3. A pulsed ion beam of a milliampere of submicrosecond duration has been easily obtained with a low power pulser. The rise time of the pulsed current is 0.1 μsec. (auth)

44486 MICROBEAM COLLIMATOR. Samsky, D. N.; Glass, W. A.; Herndon, H. V. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Rev. Sci. Instrum., 38: 1377 (Oct. 1967). (BNWL-SA-1188).

A collimator is described which restricts a beam of charged particles to a few microns in radial extent. The collimator is a double aperture device and provides a pressure differential of one atmosphere with no foil window. (auth)

44487 MEASUREMENT OF THE SHAPE OF ACCELERATOR BEAM PULSES. Frederick, D. E. (Ames Lab., Iowa). Nucl. Instrum. Methods, 54: 329-30(Oct. 1967). (IS–1612).

An accelerator timing signal and a logic signal derived from an accelerator-produced nuclear event are used to gate on and off, respectively, a train of crystal-controlled oscillator pulses. The frequency distribution of the number of gated oscillator pulses yields detailed information about the accelerator beam pulse shape. (auth)

44488 EXTENDIBLE-ENERGY SYNCHROTRONS. Garren, A. A.; Lambertson, G. R.; Lofgren, E. J.; Smith, L. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 54: 223-8(Oct. 1967). (UCRL–17471).

Synchrotron guide-field arrangements were developed that provide for a convenient and economical later increase in energy by the addition of components omitted in the initial construction.

Criteria for the design of such an accelerator include new considerations such as emphasis on small circumference to reduce initial costs and on magnet configurations for both stages that have similar orbit behavior and that require little realignment or replacement of the original magnets in the conversion. Space added for future components might also be useful to improve the accelerator in other directions. Thus, at modest cost, the initial layout would afford, in addition to specific provision for conversion to higher energy, a more general flexibility for response to future needs and exploitation of future technology. (auth)

44489 STANFORD AND ITS SUPERCONDUCTING ACCELERATOR. Fairbank, William M.; Schwettman, H. Allen. Cryog. Eng. News, 2: 46-9(Aug. 1967).

A discussion of the Stanford linear accelerator is presented. The main topics are the role of superconductivity and superfluidity, accelerator experiments, and present and future tests. (R.C.M.)

44490 RADIAL MOTION OF ELECTRONS IN A STANDING WAVE LINAC. Jamnik, D. (Univ. of Illinois, Urbana). Nucl. Instrum. Methods, 54: 297-300(Oct. 1967).

Radial motion in a standing wave electron linac is discussed qualitatively and numerical results for selected cases are presented. (auth)

44491 MULTI-PARTICLE RF-SYSTEM FOR THE IKO SYNCHROCYCLOTRON. Van Genderen, W. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instrum. Methods, 54: 288-92(Oct. 1967).

An rf system of novel design has been installed in the synchrocyclotron of the IKO in Amsterdam. Protons, deuterons, alpha-particles, $^3He^{2+}$-ions and possibly heavy ions can be accelerated since a frequency range from 10 to 24 MHz corresponding to e/m ratios between 1.1 and 0.4 is covered in three frequency bands. The characteristic impedance of the transmission line is varied with movable panels. Switching over to another frequency range is accomplished by connecting one or two panels to the outer conductor of the transmission line with strips. This procedure requires only ten minutes for switching from proton to deuteron operation of the machine. (auth)

44492 THE 300 GeV ACCELERATOR: THE MACHINE. Hine, M. G. N. (CERN, Geneva). Sci. J., 3: No. 7, 31-8(July 1967).

Detailed plans for the proposed 300 GeV accelerator have now been drawn up. Europe will decide at the end of this year whether to spend £148 million on constructing the world's largest and most expensive single piece of scientific equipment. (auth) (UK)

44493 THE 300 GeV ACCELERATOR: THE PROGRAMME. Burhop, E. H. S. (London Univ.). Sci. J., 3: No. 7, 39-47 (July 1967).

The European 300 GeV particle accelerator may help in our search for new particles, such as the elusive quark and the W-particle, carrier of the weak interaction. It might also reveal whether space and time are continuous or quantized in discrete units. (auth) (UK)

44494 RADIATION PROBLEMS ASSOCIATED WITH A HIGH ENERGY EXTRACTED PROTON BEAM. Shaw, K. B.; Thomas, R. H. (Rutherford High Energy Lab., Chilton, Eng.). Health Phys., 13: 1127-32(Oct. 1967).

Extracted particle beams are taking a larger share of the operational schedules of high energy particle accelerators There are few experimental areas specifically designed for an external beam complex; it is more usual to have to fit an extracted beam line into an existing experimental hall where the space for shielding is often limited. Shielding measurements were made in the backstop on an external proton beam line and in the transverse direction along the transport beam region for Nimrod. Other problems investigated included beam loss measurements, induced radioactivity, and the dose spectrum outside shielding. (auth) (UK)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 44168 and 44474.

44495 (AD-647165) TIME DEPENDENT NEUTRON TRANSPORT FROM A POINT ISOTROPIC SOURCE AT AN ALTITUDE OF (15,240Km) 50,000 FT. George, James P.; Lavagnino, Albert (Braddock, Dunn, and McDonald, Inc., El Paso, Tex.). Nov. 17, 1966. Contract DA-49-146-XZ-532. 271p. (DASA-1820-3). CFSTI.

The results of a run of the AUGEAS Monte Carlo neutron transport code are presented. The neutron sources used are isotropic and monoenergetic, with source energies between 0.01 and 14 MeV. The source altitude is 50 k ft in a reference atmosphere. A detailed rationale for locating the neutron detector is given. The neutron flux, resolved into 20 time intervals, and the neutron fluence, resolved into 16 energy intervals, is reproduced from the code output. Comprehensive total fluence curves are presented. Detailed flux vs time and fluence vs energy histograms are presented for the representative source energies of 14 MeV and 1.4 MeV. (auth) (TAB)

44496 (AECL-2759) SOLO: A MULTIGROUP, MULTIREGION COMPUTER CODE FOR CALCULATING THE THERMAL SPECTRUM IN A LATTICE CELL. Halsall, M. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug. 1967. 53p. Dep. CFSTI. CAN $1.50.

The computer code, SOLO, was written in APEX IV, to solve thermal multigroup multiregion lattice cell problems. Fuel clusters are approximated by annular geometry and a collision probability method is used to solve the spatial dependence of the neutron flux. Input scattering matrices and group averaged microscopic cross sections determine the energy spectrum. The theory of the methods used, comparisons with experimental results, details of the input and output, and a complete listing, with annotation, of the code and its library data are presented. (auth)

44497 (AEEW-M-760) MESH REQUIREMENTS FOR NEUTRON TRANSPORT CALCULATIONS. Askew, J. R. (Atomic Energy Establishment, Winfrith (England)). July 1967. 10p. Dep. CFSTI. UK 2s. 6d.

Fine-structure calculations are reported for a cylindrical natural uranium-graphite cell using both discrete-ordinate and collision-probability code solution methods with the WIMS code, with variations in the spatial mesh. It is suggested that of formulations assuming the source constant in a mesh interval the differential approach is generally to be preferred. Due to cancellation between approximations made in the derivation of the finite difference equations and the errors in neglecting source variation, the discrete ordinate code gave a more accurate estimate of fine structure for a given mesh even for unusually coarse representations. (auth) (UK)

44498 (BNL-11707) NEUTRON THERMALIZATION IN FINITE MEDIA. Dorning, J. (Brookhaven National Lab., Upton, N. Y. Columbia Univ., New York). July 1967. 117p. Dep. CFSTI.

A two-pronged investigation into the time-dependent behavior of the thermal neutron flux following the introduction of a burst of neutrons into a finite moderating medium is presented. After the general introduction, a simple isotropic one-term degenerate scattering kernel is assumed, and the resulting transport operator is examined in detail. The integral form of the space-, energy-, and time-dependent transport equation in slab and spherical geometries is utilized in proving four theorems which determine the nature of the time decay constants as a function of system size. The theorems are then verified by actual calculation of the decay constants. Estimates of the energy, angle, and spatial dependence of the solutions are also obtained. A discussion of realistic modern scattering models for light water and an introduction of the method of solution of the neutron transport equation are then presented. Following this, the results of fundamental mode decay constant calculations for spherical geometries using realistic H_2O scattering models are reported and are compared with experiment. The agreement is found to be quite good. The computed energy spectra and angular distributions of the fundamental mode neutron fluxes are discussed and physical interpretations of their behavior proffered. The effects of including various orders of anisotropy in the scattering kernel, and of the utilization of "transport corrected" cross sections are discussed and are demonstrated. Size-dependent extrapolation distances and bucklings are determined from the spatial distribution of the fundamental mode solutions. The bucklings thus obtained are coupled with the computed decay constants for corresponding systems, and the coefficients (i.e., the diffusion coefficient and the diffusion cooling coefficient) of the buckling expansion for the decay constant are determined. The effects of chemical binding in neutron thermalization are shown to be significant by comparison of decay constant calculations based on a model which neglects chemical binding with those based on models which include this effect (and yield results in good agreement with experiment). (auth)

44499 (CONF-660925) INTENSE NEUTRON SOURCES. Proceedings of a United States Atomic Energy Commission/European Nuclear Energy Agency Seminar, Santa Fe, New Mexico, 19-23 September 1966. (European-American Nuclear Data Committee. European-American Committee on Reactor Physics. Los Alamos Scientific Lab., N. Mex.). 851p. Dep. CFSTI.

Separate abstracts were prepared for 23 of the 30 papers included. The other 7 papers were previously abstracted for NSA (20:40455, 43460, 45205, 46559, and 21:4408, 5461, 7332). (D.C.W.)

For abstracts of individual papers see: 44500-44521 and 44660.

44500 (CONF-660925, pp 11-45) STUDIES OF CONDENSED MATTER USING NEUTRONS. Brugger, R. M. (Idaho Nuclear Corp., Idaho Falls).

Certain properties of condensed matter can be investigated with neutrons. The advantages that neutrons have for these measurements and the success that has been achieved in locating atoms in condensed matter, observing the microscopic motion of the atoms, and determining the effects of neutron damage are outlined. Speculations are made of the future applications of neutrons, especially when higher intensity sources become available. (auth)

44501 (CONF-660925, pp 47-88) NUCLEAR PHYSICS EXPERIMENTS PERFORMED WITH NEUTRONS. Bollinger, L. M. (Argonne National Lab., Ill.).

The basis for an interest in higher fluxes of neutrons from the point of view of nuclear physics is discussed. Most of the paper is devoted to a consideration of the need for more intense sources than are now available. As a result, the paper is not a general review of nuclear physics performed with neutrons. (S.F.L.)

44502 (CONF-660925, pp 119-55) CAPABILITIES AND LIMITATIONS OF HIGH FLUX REACTORS UNDER DESIGN OR CONSTRUCTION. Dautray, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Elements are given concerning the "Brookhaven high flux beam reactor" (HFBR), the German-French high flux reactor (GFHFR), the United Kingdom high flux beam reactor (UKHFBR), the Oak Ridge high flux irradiation reactor (HFIR), the Savannah River high flux demonstration (SRHFD), as well as some elements concerning SM-2, and the Argonne Advanced Research Reactor (AARR). In order to study the possibilities of these reactors, a brief description of each is given, together with a list of their irradiation beam tubes, their actinide irradiation characteristics, the other equipment for irradiation, the available fluxes, the background noises in the beams, the space available in the buildings, the duration of the cycle, the annual expenditures of these reactors, and the present state of these installations. Certain characteristics and limitations of reactors with emitted beams, of HFIR and of SRHFD, are examined, in the case of basic technology, just slightly modified. (auth)

44503 (CONF-660925, pp 215-59) THE ARGONNE ADVANCED RESEARCH REACTOR (AARR). Shaftman, D. H.; Savio, R. P. (Argonne National Lab., Ill.).

A description is given of the Argonne Advanced Research Reactor (AARR) which is being designed as a multipurpose research facility for experiments requiring high-intensity fluxes of thermal neutrons. It will be located at the DuPage County, Illinois, site of Argonne National Laboratory so as to be close to facilities at Argonne and to be readily accessible to scientists at Argonne and from the community of midwest universities. Initial power operation is scheduled for 1970. (S.F.L.)

44504 (CONF-660925, pp 261-79) A U.K. STUDY FOR A HIGH FLUX BEAM REACTOR. Crocker, V. S.; Halliday, D. B. (Atomic Energy Research Establishment, Harwell (England)).

A number of possible designs for a reactor that would yield a thermal neutron flux of about $2 \times 10^{15} cm^{-2} sec^{-1}$ at a power of 100 MW were studied. The results are summarized; and a heavy-water-cooled and -reflected reactor that provides 5 main horizontal beam tubes, 12 inclined and vertical holes, and some small irradiation positions in the core and reflector is proposed. (D.C.W.)

44505 (CONF-660925, pp 281-310) PROJECT STUDIES FOR THE FRANCO-GERMAN HIGH FLUX REACTOR. Beckurts, K. H.; Dautray, R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaire (France)).

The results of some design studies which were made for a high-flux reactor that is to be used for beam-tube experiments in liquid, nuclear, and solid-state physics are summarized. The reactor will provide a thermal neutron flux of at least 1.0×10^{15} cm^{-2} sec^{-1} in a large heavy water reflector and will have a total power of about 55 MW. The experimental facilities, including cold and fast neutron sources, are briefly discussed. (D.C.W.)

44506 (CONF-660925, pp 319-70) LIMITATIONS OF STEADY STATE, HIGH FLUX REACTORS: CURRENT AND FUTURE. Spinrad, Bernard I. (Argonne National Lab., Ill.).

The limitations of present reactor designs with respect to achieving higher power densities and briefly discussed together with some approaches to reactor design that may permit higher power densities. (D.C.W.)

44507 (CONF-660925, pp 373-411) THE SORA REACTOR: DESIGN STATUS REPORT. Larrimore, J. A.; Haas, R.; Giegerich, K.; Raievski, V.; Kley, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The design studies for the SORA reactor, which have been underway at the Ispra Center of EURATOM since 1962, are described with special emphasis on detailed studies of general interest for pulsed fission neutron source design. SORA is a periodically pulsed fast reactor with mean power of 0.6 to 1 MW. Reactivity pulsing is done with a reflector block rotating at 50 cycles per second past one face of a compact core. The design was optimized as a source for thermal and cold neutron experiments using time-of-flight techniques. The overall reactor design is briefly described. Special problems in physics design; reactor core, and pulsation device design, dynamics and control; and reactor hazards are discussed. (auth)

44508 (CONF-660925, pp 413-24) A MULTIPLE PULSED TRIGA-TYPE REACTOR FOR NEUTRON BEAM RESEARCH. Whittemore, W. L.; West, G. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A study was made of a modification of a thermal reactor to permit its use as a rapidly pulsed source of neutrons for beam research. Certain essential features of the inherent safety of the TRIGA were retained, but changes in the design permit the reactor system to be pulsed many times per second to peak power levels in the 50 to 100 megawatt region. The average power for 50 pulses/sec will be in the range 4 to 10 megawatts. Such a peak power will produce a peak neutron flux at the core end of beam tubes of the order 10^{18} cm^{-2}/sec^{-1}. The width of the pulse (order of 2 to 3 msec) requires a chopper for some neutron beam work, but this pulse width makes it relatively easy to provide appropriate phasing of the chopper. This thermal reactor has characteristics which make it also well suited for use with a large, cryogenic source to produce cold neutrons. (auth)

44509 (CONF-660925, pp 431-49) THE SUPERBOOSTER. Poole, M. J. (Atomic Energy Research Establishment, Harwell (England)).

A design study made at AERE to determine the suitability of accelerator-booster systems for the provision of thermal neutron beams for solid state research is described. The system considered was a pulsed traveling wave electron linac, of 300 kW mean, and 200 MW peak beam power operating into a subcritical plutonium-fueled liquid metal cooled fast reactor. The reactivity of this assembly was oscillated in phase with the linac pulsing so that the multiplication of delayed neutrons emitted between pulses is reduced while maintaining maximum usable multiplication at the moment of the pulse. Problems considered include design of the accelerator and beam handling system; design of the reactor core; stresses set up in the fuel due to thermal pulsing; methods of oscillating reactivity; thermalization of neutrons; layout of beam holes and number of neutron beams available; design of the containment building and general safety problems. The conclusion reached is that it should be possible to build a plutonium–carbide-fueled reacting system operating at a prompt multiplication during the pulse of 300 and with a mean power of around 9 MW. This could feed up to 20 neutron beams (various geometries have been considered) from an effective thermal flux during the pulse of 2×10^{16} n/cm^2 sec. The pulse length and repetition rate for this are ~60 μsec and 200 pulses/sec, respectively. Alternatively, it is possible to use smaller moderators to yield a pulse of ~20 μsec long, when the effective flux is reduced to 7×10^{15} n/cm^2 sec. (auth)

44510 (CONF-660925, pp 451-84) OPERATING CHARACTERISTICS OF ACCELERATOR-BOOSTER PULSED RESEARCH REACTORS. Stevens, C. A.; Beyster, J. R.; Russell, J. L. Jr. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

The feasibility study of an accelerator-booster fast repetitively pulsed research reactor is discussed. Desirable operating characteristics for the booster are determined, together with its dependence upon the associated linac. Fast neutron burst shapes, power levels, and problems of thermalizing the fast neutrons to obtain short intense bursts of thermal neutrons are discussed. Alternative reactor core, coolant, and reflector materials are examined for possible use in the booster. Briefly, the principle of operation is as follows. A rotating reactor component varies the reactivity of a fast reactor periodically between a peak which is below prompt critical and a minimum of a few dollars subcritical. At the high point of the reactivity swing, a linear accelerator produces a burst of neutrons in the reactor. The booster then multiplies this neutron intensity by a factor which exceeds 100. The fast neutrons leak into a hydrogenous moderator which is located outside of the fast core. The result is an intense burst of thermal neutrons which is available for time-of-flight experiments such as neutron diffraction or inelastic scattering. The reactivity is low between pulses, so that the power level in the reactor between pulses is low, as is the neutron background. The motivation for this type of research reactor is that large time dependent thermal neutron fluxes can be produced in a reactor which operates at a relatively low average power level. In this way heat removal, shielding, fuel burnup, and other problems associated with high power reactors can be minimized. (auth)

44511 (CONF-660925, pp 491-508) COMPARISON OF REPETITIVELY PULSED DEVICES. Raievski, V. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The main design characteristics of various pulsed systems are reviewed with the objective of comparing and contrasting the operation of ordinary pulsed reactors and pulsed reactors with source injection from a linear accelerator. A survey of existing proposals is made with special reference to the one system (the Russian IBR) already in operation. (auth)

44512 (CONF-660925, pp 565-87) CYCLOTRONS, SYNCHROCYCLOTRONS, AND SYNCHROTRONS AS PULSED HIGH INTENSITY NEUTRON SOURCES. Havens, W. W. Jr. (Columbia Univ., New York).

Cyclotrons, synchrocyclotrons, and synchrotrons are not extensively used as pulsed neutron sources because their inherently pulsed nature is a disadvantage for most experiments. The success of the mechanisms used to remove the beam microstructure and the spreading of the beam because of phase stability in the synchrotron makes existing synchrotrons not very useful as pulsed neutron sources. The use of high energy protons to produce neutrons increases the length of the source because the range of the proton increases rapidly with energy. Examination of the geometry of neutron spectrometer collimating systems and source and detector sizes leads to the conclusion that the maximum energy protons useful for neutron time-of-flight spectroscopy is about 1 BeV. No single criterion appears suitable for comparing cyclic particle accelerators as pulsed neutron sources. The time-of-flight field has been divided into slow and fast neutron time-of-flight spectroscopy on the basis of the neutron energy response of the detector. The slow neutron detector responds to thermal neutrons and the fast neutron detector has a neutron energy threshold. The criteria finally chosen for comparisons are the maximum intensity of the burst and the average neutron intensity when the accelerator is used as a neutron spectrometer. The accelerators now used for neutron spectroscopy, proposed improved existing accelerators, and proposed accelerators are compared as neutron spectrometers. (auth)

44513 (CONF-660925, pp 589-98) SECTOR-FOCUSED CYCLOTRON AS A POWERFUL TOOL FOR FAST NEUTRON TIME-OF-FLIGHT RESEARCH. Cierjacks, S.; Forti, P.; Kropp, L.; Unseld, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandt Kernphysik).

At the Karlsruhe Isochronous Cyclotron a fast neutron time-of-flight spectrometer was put into operation and the first measurements were carried out. The performance data of this apparatus are as follows: average unmoderated 4π neutron output per second $I_s = 2 \times 10^{13}$ neutron/s at maximum, neutron pulse width $\tau = 1 \pm 0.3$ ns (f.w.h.m.); pulse repetition rate 20 kc/s and

length of the length of the flight path 57 m at present. The figure of merit $M = L_s/\tau^2$ thus is about 1×10^{31} s^{-3}. Possible improvements for the spectrometer are discussed. In addition, general aspects of the use of sector-focused cyclotrons as very intense pulsed neutron sources are considered; in particular, neutron production is discussed in relation to cyclotron design features. Finally, an outline of possible experiments is given for which very intense fast neutron time-of-flight devices are advantageous. (auth)

44514 (CONF-660925, pp 605-21) ELECTRON LINEAR ACCELERATORS AS SOURCES OF HIGH INTENSITY NEUTRON BURSTS. Leiss, J. E. (National Bureau of Standards, Washington, D. C.).

Electron linear accelerators are used as nonbooster sources of neutrons in two distinct modes of accelerator operation, in the accelerator steady-state and in the transient or stored-energy mode. The basic neutron production process in heavy elements is examined, and accelerators are proposed for each mode of accelerator operation which illustrates the present state of the art. (auth)

44515 (CONF-660925, pp 623-34) INTENSE SOURCE OF NEUTRONS FROM THE DENSE PLASMA FOCUS. Mather, J. (Los Alamos Scientific Lab., N. Mex.).

The dense plasma focus (created in a coaxial accelerator) is an intense source of neutrons. The plasma focus can be described as a fast dynamic z-pinch in which stored magnetic energy is rapidly converted to plasma energy and then compressed by its self magnetic field. Plasma pressures (nkT) of the order of 3×10^5 atmospheres are developed on axis in a region of ~0.5-mm diameter and 3 to 5 mm in length. The deuterium plasma density $n \approx 2$ to 3×10^{19}/cc, electron temperature T ~5 keV and a neutron pulse duration of ~0.15 μsec lead to a large neutron emission which is not inconsistent with the assumption of thermonuclear origin. The performance of the plasma focus in terms of neutron production, quoting only what has been achieved is $\approx 2.2 \times 10^{17}$ neutrons per sec. [$D + D \rightarrow He^3 + n$ (2.45 MeV)] in a burst time of ~0.15 μsec for a condenser energy of ~40 kJ. Scaling studies from 10 to 40 kJ of condenser energy result in an almost linear increase of neutron production. The substitution of a 50/50 gas mixture of deuterium and tritium [$D + T \rightarrow He^4 + n$ (14 MeV)] for the pure deuterium gas shows an increase in neutron production by a factor of 80 to 100. D–D and D–T neutron flight time measurements were made over a flight path of 12 meters; their velocities correspond to neutron energies of 2.45 and 24 MeV respectively. Scaling of the dense plasma focus to larger input energies and larger physical size should permit, on the basis of experimental evidence, higher neutron production. For example, condenser energies in the 250 kJ range should yield a neutron production rate of $\approx 10^{18}$ n/sec from the D–D reaction and correspondingly higher ($\approx 10^{20}$ n/sec) for the D–T reaction. The characteristics of this type of source which are relevant to its potential use as a neutron source in experiments are discussed. (auth)

44516 (CONF-660925, pp 637-60) SPALLATION-TYPE THERMAL NEUTRON SOURCES. Bartholomew, G. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.).

A presentation is given of the thermal neutron capabilities of spallation-type sources, and a comparison is made with the capabilities of other devices for thermal neutrons. The breadth and versatility of the Intense Neutron Generator (ING) as presently conceived is shown, and the evolution of the project from initial needs for higher thermal flux, to future programs is outlined. (S.F.L.)

44517 (CONF-660925, pp 661-73) PROSPECTS FOR HIGH CURRENT ACCELERATORS. Nagle, Darragh E. (Los Alamos Scientific Lab., N. Mex.).

A number of studies have been made and several projects are underway to construct very high current accelerators in the energy range 200 to 1000 MeV. Some of the problems which appear at higher currents are discussed including problems of beam quality from the ion source, preaccelerator, and transport system; problems of space-charge defocusing of strong focusing fields; beam-loading effects; cavity-beam instabilities or amplification; targeting problems; and the economic and systems problems of supplying the power for the accelerating beam. (auth)

44518 (CONF-660925, pp 701-30) DESIGN STUDIES FOR THE EXPERIMENTAL EQUIPMENT AT A VERY HIGH FLUX REACTOR. Armbruster, P.; Maier, G.; Scherm, R.; Schmatz, W.; Springer, T. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Neutronenphysik).

At research reactors, the intensity and the statistical accuracy can be improved by an increase of the reactor power as well as by careful optimalization of the experimental equipment. Both should be done during the development of a very high flux reactor. Four studies concerning the optimalization of various experiments are discussed. The lay-out criteria for a bunch of neutron conductors originating at a cold source are discussed, and a system with five separated neutron conductors is proposed in more detail. Two types of small angle scattering instruments are compared, namely a focusing and a non-focusing system for certain classes of experiments, a high-resolution double chopper and a triple-axis spectrometer are compared with respect to intensity and applicability; and a fission fragment separator of the focusing parabola type is proposed with a mass resolution of approximately 800. These investigations are theoretical studies. However, experimental experience obtained so far from work at the FRM and the FRJ-2 reactors was very important for many conclusions. Most of the work was stimulated by preliminary discussions of the beam hole program for the German–French very high flux reactor project. (auth)

44519 (CONF-660925, pp 733-61) PANEL DISCUSSION ON STRUCTURE STUDIES INVOLVING DIFFRACTED NEUTRONS.

The methods of conventional neutron diffraction and the methods of time-of-flight diffraction are reviewed, and the best characteristics of each technique are discussed. Discussions are given on such topics as intensity, resolution, reliability of the data, and procedures to obtain structure factors from the experimental data, and the advantages and disadvantages of these methods for the study of solids and liquids. (S.F.L.)

44520 (CONF-660925, pp 763-87) PANEL DISCUSSION ON INELASTIC SCATTERING.

Experimental techniques associated with inelastic neutron scattering are discussed. It is shown that for a large number of experiments, including inelastic and elastic scattering, where not only the energy, but also the momentum transfer, has to be measured accurately, the burst width is determined by the diameter of the neutron source and the velocity of the neutrons used in the experiments. The focusing properties of rotating crystals are also discussed. (S.F.L.)

44521 (CONF-660925, pp 819-34) PANEL DISCUSSION ON NUCLEAR PHYSICS.

Brief discussions are given on: neutron fundamental experiments; (n,γ) spectroscopy with thermal neutrons; production of rare isotopes for decay studies; production of γ-ray sources by thermal capture; resonance neutron capture γ rays; and fast-neutron nuclear physics. (S.F.L.)

44522 (EANDC–63(U)) INTENSE NEUTRON SOURCES AND THEIR USES. Report of a Group of Experts, Santa Fe, September 1966. (European–American Nuclear Data Committee). Mar. 1967. 14p. Dep.

Some recommendations for the development of intense neutron sources are presented; and the applications of intense sources to research in neutron physics, nuclear physics, and condensed matter are briefly discussed with emphasis on the source requirements. (D.C.W.)

44523 (JUL–444–MA) DIE NUMERISCHE BEHANDLUNG DER ENERGIEABHAENGIGEN, EINDIMENSIONALEN TRANSPORTGLEICHUNG MIT QUELLTERM. (The Numerical Treatment of the Energy-Dependent, One-Dimensional Transport Equation With Source Terms). Meuer, Hans Werner; Richter, Lutz (Kernforschungsanlage, Juelich (West Germany). Zentralinstitut fuer Angewandte Mathematik). Dec. 1966. 50p. (In German). Dep.

The transport equation, an integral-differential equation, was reduced by consideration of the boundary conditions to a Fredholm integral equation of the second type. The numerical solution of this integral equation is done, after suitable treatment of the singularities, by means of approximation through an inhomogeneous system of linear equations. The two-dimensional structure leads to very large systems of equations which can be solved only by computers of great memory capacity and high internal processing speed. The program selected was written for the IBM 7090. The method was tested using the example of the angular-independent free gas kernel. (tr-auth)

44524 (NAA–SR–12494) A NEW USE OF ADJOINTS IN THE MONTE CARLO ESTIMATION OF RESONANCE INTEGRALS. Levitt, L. B. (Atomics International, Canoga Park, Calif.). Sept. 5, 1967. Contract AT(04-3)-701. 20p. Dep. CFSTI.

The Monte Carlo analysis of resonance integral experiments involving the insertion of a small material sample into a large moderating region of a reactor encounters difficulty due to the paucity of neutrons in the moderator which actually see the

sample prior to thermalizing. This cannot, in general, be remedied by picking source neutrons incident on the surface of the sample since the distribution of such particles is not known. It is possible in a Monte Carlo calculation, however, to consider neutrons incident on the surface of the sample which have not been previously aware of the sample's existence. This source can readily be obtained by: calculating the distribution in energy and direction which would exist on the outer surface of a hole in an infinite medium of moderating material; selecting initial direction cosines α, β, and γ, and initial energy, E_0, from the above mentioned distributions, and selecting position coordinates from a uniform distribution incident on the sample (adjoint particles are followed backward in configuration space, collision by collision, until their energy, position, or both, have reached regions in which the actual neutron flux is unperturbed by the presence of the sample); and accepting a neutron as a source particle only if the adjoint path does not enter the sample at anytime, since this would violate the condition upon which this source is constructed. Once this source has been obtained by following the outlined procedure, neutrons selected from it may be followed forward in phase space until their energy is below E_{min}, the lower bound of the resonance energy band. The estimation procedures used in this portion of the calculation are independent of the methods used to obtain its source. Therefore, they can be readily adapted to the physical and geometric properties of the sample. The described technique has been programmed for both the IBM 7094 and the system 360 in a code named TRAFE, a treatment of resonances using adjoint and forward estimators. (auth)

44525 (WAPD-T-2028) SOLUTION OF THE DISCRETE ORDINATE EQUATIONS IN ONE AND TWO DIMENSIONS. Gelbard, E. M.; Davis, James A.; Hageman, L. A. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1967. Contract AT(11-1)-Gen-14. 48p. (CONF-670410-2). Dep. CFSTI.

From American Mathematical Society Meeting, New York.

Some methods of solving discrete-ordinate equations are reviewed. All of the methods considered are applicable to multigroup transport equations, but only the monoenergetic neutron transport equation is discussed. Numerical techniques for treating one-dimensional problems are considered first; two-dimensional configurations are then discussed. (D.C.W.)

44526 GENERATOR OF NEUTRON IMPULSES OF NANOSECOND RANGE. Fedorov, M. B.; Yakovenko, T. I. Ukr. Fiz. Zh., 12: 1032-4(June 1967). (In Russian).

A nanosecond neutron pulse generator was developed in order to determine the neutron energy by measuring the time of flight. The pulsed deuteron beam was obtained directly after the ion source in order to decrease the neutron background in the intervals between pulses. A longitudinal variable electric field having a frequency of 5×10^6 cycles/sec acts on a deuteron beam coming from a high-frequency resonance source. The ions which are thus modulated according to velocity are grouped into bundles during the time of flight from the grouper to the heavy ice target. Two gaps with a voltage of 2 kv were used for the grouping. Deflecting plates at a distance of 12 cm from the second gap were used to remove the beam between pulses. Starting pulses are fed to an oscillograph and to one of the time interval converter inlet leads. The duration of a pulse front is determined by the rise time of the amplifier. The spectrum of a direct neutron beam was obtained with the use of a stilbene crystal and a photomultiplier tube. The system can be used as a neutron spectrometer with the use of a photomultiplier having good time resolution. (TTT)

44527 STUDY ON THE THERMAL NEUTRON SPECTRA IN THE UNDERMODERATED REACTOR SYSTEM BY FOIL ACTIVATION TECHNIQUE. Kanda, Keiji (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, 76: 149-57(Mar. 1967).

Thermal neutron spectra in the under-moderated system consisting of natural uranium and light water were measured by the foil activation method using several nuclides. Activation data were reduced to continuous neutron spectra by the orthogonal expansion method. The reduced results were compared with the THERMOS spectra theoretically calculated. (NSA of Japan)

44528 TIME BEHAVIOR OF A REACTOR AND ERGODIC THEORY OF SEMIGROUPS. Hejtmanek, Hans (Oesterreichische Hochschule, Vienna). J. Math. Phys. (N. Y.), 8: 1401-5 (July 1967).

The solution of the time-dependent neutron transport equation is a semigroup of linear transformations acting on a Banach space. There are some ergodic theorems that can be used to describe the asymptotic behavior of the solution under very general conditions on the semigroup. The results are compared with Wing's famous approach. (auth)

44529 SCATTERING CROSS SECTIONS OF SLOW POLARIZED NEUTRONS IN A UNIAXIAL ANTIFERROMAGNETIC MATERIAL. Zarochentsev, E. V.; Popov, V. A. (Rostov State Univ., USSR. Inst. of Low Temperature Physics and Tech., Kiev). Fiz. Metal. Metalloved., 22: 487-97(Oct. 1966). (In Russian).

Neutron scattering cross sections were calculated using Green functions, taking into account magnon-magnon, magnon-phonon, and phonon-phonon interactions influencing the width Γ of energy peaks of scattering. It is shown that the cross section of elastic or inelastic (single particle) scattering from polarized neutrons in the incident beam is the function of antiferromagnetic magnetization. The width Γ was calculated as a function of the temperature, external magnetic field, and pulse of the incident and scattering neutrons. (tr-auth)

44530 OBSERVATION ON THE BEHAVIOR OF ^3He IN ZrT_2 AND IN ZIRCONIUM METAL. Vertebnyi, V. P.; Vlasov, M. F.; Kirilyuk, A. L.; Zatserkovskii, R. A.; Pasechnik, M. V.; Stepanenko, V. A. At. Energ. (USSR), 22: 235-7(Mar. 1967). (In Russian).

Helium can be introduced into a sample by the beta decay of tritium: $^3T \rightarrow {}^3H_3 + \beta$. Since ^3He has a relatively large cross-section for thermal neutrons, the concentration of He in the sample can be readily determined by measuring the transparency of the sample to slow neutrons. ^3He was accumulated in a $ZrT_{1.9}$ sample for periods of 16 hr, 21 days and 5 months. Transmission experiments with neutrons showed that ^3He was not evolved from $ZrT_{1.9}$ at room temperature up to concentrations of 25 He atoms per 1000 Zr atoms. On heating the samples, an intensive evolution of tritium gas was observed at 350°C. Helium (^3He) was evolved at 800 to 900°C, where a sharp change in the neutron transparency of the samples took place. The accuracy of determining the transparency is about 0.01%, which corresponds to a change in He concentration of 10^{-5}%. (TTT)

44531 AVERAGE NEUTRON COLLISION PROBABILITY FOR FINITE CYLINDERS AND OTHER CURVED BODIES. Zharkov, V. A.; Terent'ev, V. P. At. Energ. (USSR), 22: 229-30(Mar. 1967). (In Russian).

The average probability P of a single neutron collision with a substance is tabulated for a sphere, an infinite cylinder, an infinite plane, and an ellipsoid of revolution. The behavior of the probability of collision for finite cylinders $P_{fin.\ cy.}$ was investigated and tabulated for values of $\alpha = 1$, 2, and 4. Here $\alpha = R/H$, where R is the cylinder radius and H is the height. The probability for a body of arbitrary configuration $P_{arb.}$ is conveniently considered as a function of the term $a = \Sigma\ (4V/S)$, where Σ is the neutron interaction cross-section, and V and S are the volume and surface area of the body. Values of $P_{arb.}$ are listed for values of a from 0.2 to 5.0. Probability values for finite cylinders with any value of α are accurate to 0.1%. The formula for calculating probability values for bodies having an arbitrary configuration has an accuracy of 5 to 10%. (TTT)

44532 POSITION-DEPENDENT NEUTRON SPECTRA IN A MULTIPLYING MEDIUM. Cerbone, R. J.; Slovacek, R. E.; Gaerttner, E. R. (Rensselaer Polytechnic Inst., Troy, N. Y.). Nucl. Sci. Eng., 30: 75-84(Oct. 1967).

Position-dependent thermal spectra were measured in a paraffin-moderated ^{235}U multiplying assembly using two independent methods. Steady-state spectra were obtained with the time-of-flight technique employing a 24.40-m flight in conjunction with the Rensselaer Polytechnic Institute linear accelerator; asymptotic (in time) spectra were obtained with the pulsed-LINAC chopper technique. A new technique was developed to monitor the source intensity with a tracking reliability of ±1.5%. The measured spectra are compared to a series of DTF-IV transport calculations using a P_1 kernel and P_1 source; the spatial source was obtained from a transport calculation. The spectrum calculations were performed with a polyethylene kernel utilizing either the Goldman model or the Koppel–Young four-oscillator model. The experimental spectra are generally in closer (better than 5%) agreement with calculations using the Goldman kernel than with those using the Koppel–Young kernel. This result is consistent with the total cross section of polyethylene measured by Armstrong. (auth)

44533 ITERATION AND INTERMEDIATE RESONANCE ABSORPTION. Goldstein, Rubin (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Nucl. Sci. Eng., 30: 146 (Oct. 1967). (BNL-10881).

An iterative method for solving equations of the form $H\psi = s$, where H is some operator, s is a given source, and ψ is the unknown solution, is outlined. The application to intermediate resonance absorption, where $H = s + \sigma - K\sigma$, with K a slowing-down operator, is stressed. The iterative solution is compared with

exact and iterative solutions for the 192-eV resonance of ^{238}U. (D.C.W.)

44534 ANISOTROPIC SCATTERING IN CELL PROBLEMS. Benoist, Pierre (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Sci. Eng., 30: 85-94(Oct. 1967).

A general expression allowing the calculation of the influence on cell factors of an anisotropic component of the scattering law in a given medium is established in the framework of the integral transport theory. This expression is applied to the calculations of the thermal utilization, fast fission factor, and diffusion coefficients. In the case of the thermal utilization, the effect of the anisotropic scattering in the moderator can be taken into account by a rigorous correction whatever the cell; this correction coincides with the classical transport correction only for widely spaced lattices, and still with some restrictions; for closely packed lattices the transport correction has no theoretical justification, and seriously underestimates the effect. In the fuel, the transport correction is no more theoretically justified, although it leads to good results for rather large rods; a very simple formula is established from the general expression, allowing the calculation of the correction to f, without using the transport cross section. This formula leads, for all the rod diameters considered, to results in very good agreement with referenced values obtained by the S_8 method. An analogous formula for the fast-fission factor is established. (auth)

44535 COLLISION PROBABILITIES FOR FINITE CYLINDERS AND CUBOIDS. Carlvik, I. (Aktiebolaget Atomenergi, Stockholm, Sweden). Nucl. Sci. Eng., 30: 150-1(Oct. 1967).

The collision probabilities for cylinders and cuboids were derived by considering the current out of the surface from a constant source density inside the body. A closed formula containing double integrals was obtained for finite cylinders, while the collision probability for a cuboid was expressed by single integrals. (D.C.W.)

44536 CONVERGENCE OF THE SOURCE ITERATION TECHNIQUE IN SOLUTION OF THE MULTIGROUP NEUTRON TRANSPORT OR DIFFUSION EQUATIONS WITH EXTERNAL SOURCE. Spinks, N. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nucl. Sci. Eng., 30: 152-4(Oct. 1967).

The divergence of the source iteration technique for solving the time-independent multigroup neutron transport or diffusion equations for problems involving an external source in a supercritical reactor is studied. The technique is extended to yield the solution in all cases. (D.C.W.)

44537 TEMPERATURE DEPENDENCE OF PARAMAGNETIC NEUTRON SCATTERING. Sears, V. F. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 45: 2923-9 (Sept. 1967).

The effect of short-range order on the paramagnetic exchange broadening of magnetic neutron scattering cross sections is investigated theoretically by expanding the second moment of the energy transfer in inverse powers of the temperature. The results are applied to terbium, where it is found that the first temperature correction gives a substantial improvement in the agreement between theory and experiment. (auth)

44538 COLD NEUTRON SCATTERING BY LIQUID METHANE. Rao, K. R.; Venkataraman, G.; Dasannacharya, B. A. (Bhabha Atomic Research Center, Trombay, Bombay). Can. J. Phys., 45: 3185-6(Sept. 1967).

The differential scattering cross section for liquid methane at 98°K was calculated using a partial-wave treatment of the rotations and taking into account rotational relaxation functions of the third and fourth order. The contributions of the various partial waves were analyzed; it was found that the $l = 3$ and $l = 4$ partial-wave terms make small but significant contributions. A comparison of the theoretical results with some experimental data showed that the inclusion of higher-order terms gave better agreement than a similar treatment in which only the first- and second-order terms were considered. It also appears that the use of a more realistic model for the center-of-mass translations would be advisable. (D.C.W.)

44539 INTERNATIONAL COMPARISON OF MEASUREMENTS OF THE LEVEL OF EMISSION OF THE NEUTRON SOURCE Ra-Be$(\alpha,n)n^0$ 200-1 OF THE NATIONAL RESEARCH COUNCIL. Naggiar, V. (Bureau International des Poids et Mesures, Sevres, France). Metrologia, 3: 51-2(Apr. 1967). (In French).

A comparison of measurements of the neutron emission level of a source donated by the Conseil National de Recherches is reported. The analysis in each case was by measurement of the slowing down and capture of neutrons emitted when the source was submerged in a $MnSO_4$ solution, and the activity of ^{56}Mn was determined. Total error reported by the laboratories varied between 0.7 and 1.7%. The maximum deviation between results was 3%, and the arithmetic mean was 3.269×10^6 n/sec. Values for national laboratories were given as follows: Tokyo, 3.322; Amsterdam, 3.173; Saclay, 3.279; Leningrad, 3.26; Rehovoth, 3.242; Geel, 3.31; Sevres, 3.252; Trombay, 3.208; Ottawa, 3.245; Washington, 3.215; Teddington, 3.162. (BBB)

44540 ON THE POSSIBILITY OF MEASUREMENT OF SPECTRA OF THERMAL OSCILLATIONS $G(\omega)$ WITH THE AID OF COHERENT INELASTIC SCATTERING OF NEUTRONS IN POLYCRYSTALS. Bredov, M. M.; Kotov, B. A.; Okuneva, N. M.; Oskotskii, V. S.; Shakh-Budagov, A. L. (Institut Poluprovodnikov, Leningrad). Fiz. Tverd. Tela, 9: 287-93(Jan. 1967). (In Russian).

The possibility of the direct determination of the distribution function of phonons according to frequency from inelastic coherent scattering spectra of cold neutrons in polycrystalline samples is considered. A calculation of the mean cross section for scattering in a polycrystal in the presence of multiple Bragg reflections is developed, and a function $g(\omega)$ is derived for obtaining the distribution function. An experimental appraisal of the function is made with polycrystalline Al, using new data and data obtained from the published work of others, and comparing the g function with the neutron spectrum obtained otherwise. (BBB)

44541 STABILITY ANALYSIS OF PERIODICALLY OSCILLATING COMPRESSIBLE FISSILE MEDIA. Campe, Kazimieras Mindaugas Petras. Lafayette, Ind., Purdue Univ., 1966. 116p.

Thesis.

An extension of some theoretical studies on the problem of the dynamic reactivity effect is presented in the form of analytic techniques and derivations, formulated results, and associated numerical procedures. The problem of ascertaining the criticality conditions for compressible fissile media of various geometries whose boundaries are in periodic motion is studied in a twofold approach. The first viewpoint is to derive criticality conditions for spherical and cylindrical geometries using simple one-dimensional, one-group diffusion theory without delayed neutrons. The results obtained tend to reaffirm the observations made by Powers and Bailey for an infinite slab geometry. The second approach is to transcend diffusion theory to the point of allowing the presence of a second-order time derivative in the neutron balance equation. This gives us the correct form of the P_1 approximation to the Boltzmann transport equation and results in the use of the telegrapher's form of the neutron balance equation for the mathematical representation of the actual system. The equation was analyzed in a twofold manner. On the one hand it was analytically simplified to a point where Floquet theory for periodic systems could be applied. This resulted in the proof that no anomalies in the flux oscillations for critical and supercritical slab systems existed, contrary to the predictions based on the diffusion equation results. A semianalytic approach, on the other hand, was devised to analyze the stability of the unsimplified telegrapher's equation. A computer code was written to obtain criticality conditions which are presented graphically. (Disser. Abstr.)

Nuclear Properties and Reactions, A≤5

Refer also to abstracts 44259, 44287, 44583, and 44657.

44542 (ZFK-122) PROCEEDINGS OF THE CONFERENCE ON NUCLEAR REACTIONS WITH LIGHT NUCLEI AND NUCLEAR STRUCTURE, 10-15 JANUARY 1966, IN ROSSENDORF. Schintlmeister, Josef (ed.) (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)). July 1966. 364p. (In English and German). (CONF-660118). Dep.

Separate abstracts were written for 42 of the 45 papers included in the Proceedings. Three of the papers have previously appeared in Nuclear Science Abstracts. (S.F.L.)

For abstracts of individual papers see: 44543-44545, 44562-44577, 44603-44610, and 44739-44753.

44543 (ZFK-122, pp 101-10) PHOTODISINTEGRATION OF THE LIGHTEST NUCLEI. Jibuti, R. I.; Mamasakhlisov, V. I.; Macharadze, T. S. (Akademiya Nauk Gruzinskoi SSR, Institut Fiziki).

A theoretical study is made of the three-particle photodisintegration of nuclei ^3H and ^3He by using Morpurgo's equation [Nuovo Cimento 9, 461(1952)] as the basis to find the form of the wave function of the three-particle nucleus. It is obtained from the precise Schroedinger equation for three nucleons with the assumption that the wave function of the system depends only on

the symmetrical variable $R = [\frac{2}{3}(r_{12}^2 + r_{23}^2 + r_{13}^2)]^{\frac{1}{2}}$ in which r_{ik} are internucleon distances. (S.F.L.)

44544 (ZFK–122, pp 130–5) CHARGE-INVARIANT ANALYSIS OF RESULTS OF THE INTERACTION OF NUCLEONS WITH ^{3}H AND ^{3}He AND THE EXCITED STATES OF ^{4}He. Barit, I. J.; Saikin, D. A.; Segrejev, V. A. (Akademiya Nauk SSR, Moscow. Institut Fiziki).

It is shown that taking into account charge invariance allows simplification of complicated data and interpretation of experimental data on the interaction of nucleons with ^{3}H and ^{3}He and with the excited states of ^{4}He. Total charge invariant analysis of all the data on the interaction of nucleons with ^{3}H and ^{3}He gives characteristics of the interaction in various states, which are important in studying properties of four-nucleon systems. (S.F.L.)

44545 (ZFK–122, pp 136–42) ANALYSIS OF d–t AND d–^{3}He INTERACTIONS AND EXCITED STATES OF ^{5}He AND ^{5}Li NUCLEI. Balashko, Yu. G. (Moscow State Univ. (USSR). Scientific Research Inst. of Nuclear Physics).

An analysis is made of the available experimental data on the interaction of deuterons with tritons and ^{3}He to obtain qualitative information on the excited states of ^{5}He and ^{5}Li. Some facts are pointed out which can be regarded as an indication of the $\frac{1}{2}^+$ or another $\frac{1}{2}^-$ excited level in these nuclei. (S.F.L.)

44546 THE ^{2}H(p,2p)n REACTION AT 9.0 AND 10.5 MeV. Simpson, W. Dwain; Jackson, W. R.; Phillips, G. C. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A103: 97-126(1967). (CRO–1316-36).

The ^{2}H(p,2p)n reaction was studied experimentally at bombarding energies of 9.0 and 10.5 MeV. The two protons in the final state were detected in coincidence and were energy analyzed by use of a two-parameter, pulse-height analyzer, thus completely specifying the kinematics of the reaction. The distinction between sequential and simultaneous decay for the three-nucleon system was investigated. The sequential decay of this system via the virtual deuteron was observed. A preliminary analysis of the data using the generalized density-of-states technique appears to adequately describe the reaction at these bombarding energies. (auth)

44547 THE THREE-NUCLEON PROBLEM WITH THE HAMADA POTENTIAL. Davies, B. (Flinders Univ., Bedford Park, South Australia). Nucl. Phys., A103: 165-76(1967).

Variational calculations are reported for the three-nucleon system with the Hamada potential. Extensive results for ground-state properties of ^{3}H and ^{3}He and also an upper bound on the n-d scattering length are given. While it is evident that our calculation has not yet converged, it is shown that it is reasonable to expect that a more accurate calculation would give good agreement with experiments, which is contrary to earlier expectations based on less flexible trial functions. (auth)

44548 ELECTRON SPALLATION OF ^{4}He AND ^{6}Li NUCLEI. Machabeli, I. Z. (Tbilisi State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1340-2(Aug. 1966). (In Russian).

Numerical calculations were made and curves were drawn showing, for ^{4}He, the cross-section of the (e,e'np) reaction as a function of deuterium back-scattering angle and of electron energies from 180 to 250 MeV, and of the (e,e'N) reaction as a function of electron energy. A combination of the two curves showed that the binuclear process may lead to a rise in the experimental curve at electron energies around 250 MeV. Calculations showed that the cross-section of the (e,e'd) process is approximately an order of magnitude lower than that of the binuclear process studied and has a maximum in approximately the same region. Curves for ^{6}Li of the (e,e'np) cross-section as a function of the deuterium back-scattering angle were not symmetrical with each other. The curve for 350 MeV rose abruptly at $\Theta = \pi/2$, while the others sloped very gradually downward. (TTT)

44549 SPECTRA OF NUCLEI IN THE $1p_{\frac{1}{2}}$ SHELL WITH PAIRING PLUS ISOPAIRING FORCES. Camiz, P. (Istituto Nazionale di Fisica Nucleare, Rome. Univ., Rome. Institut de Physique Nucleaire, Orsay, France). Nuovo Cim. (10), 51B: 190-4(Sept. 11, 1967).

The excitation spectra of nuclei in the $1p_{\frac{1}{2}}$ shell were calculated considering both pairing and isopairing Hamiltonians as a residual interaction. The theoretical results were compared with experimental data. A more precise analysis is recommended. (D.C.W.)

44550 POLARIZATION OF PROTONS ELASTICALLY SCATTERED FROM ^{3}H. Drigo, L.; Manduchi, C.; Nardelli, G. C.; Russo-Manduchi, M. T.; Tornielli, G.; Zannoni, G. (Univ., Padua). Nuovo Cim. (10), 51B: 43-8(Sept. 11, 1967).

The angular distribution of the polarization of protons scattered by ^{3}H was measured for proton energies of 3.16, 3.86, and 4.53 MeV and at center-of-mass angles from 64.8 to 144.8°. The main feature of the data is the large polarization occurring near 120° for all energies. (auth)

44551 INELASTIC SCATTERING OF NEUTRONS ON DEUTERONS AT 14 MeV. Saukov, A. I.; Oparin, E. M.; Chernukhin, Yu. I. Yadern. Fiz., 6: 242-6(Aug. 1967). (In Russian).

The neutron spectra from the D(n,p)2n reaction at the angles of 20, 45, 60, and 90° to the incident neutron beam (energy E_0 = 14 MeV) were measured by time of flight. The measurements are in good agreement with the theoretical spectra, calculated in the pole approximation. (auth)

44552 BINDING ENERGIES AND LIFETIMES OF LIGHTER HYPERFRAGMENTS. Holland, M. W.; Miller, H. G.; Roalsvig, J. P. (State Univ. of New York, Buffalo). Phys. Rev., 161: 911-14(Sept. 20, 1967).

In an emulsion stack exposed to a stopping K^- beam at the Bevatron, hyperfragments were observed in order to make lifetime and binding-energy measurements on the lighter hyperfragments formed. The binding energies of 28 hyperfragments with mass number $7 \leq A \leq 13$ were measured. Lifetime measurements were restricted to using the π^-pr decay modes, and three decays in flight were observed, one each of $_\Lambda H^3$, $_\Lambda He^4$, and $_\Lambda Li^7$. Combining the $_\Lambda$He data with previous measurements, the lifetime ($_\Lambda$He) = $(1.9^{+0.5}_{-0.3}) \times 10^{-10}$ sec for the $_\Lambda$He group was obtained. This value is slightly more than one standard deviation less than the predicted values for $_\Lambda He^4$ and $_\Lambda He^5$. (auth)

44553 EXPERIMENTAL STUDY OF EXCITED ^{4}H, ^{4}He, AND ^{4}Li NUCLEAR SYSTEMS. Jarmie, Nelson; Stokes, Richard H.; Ohlsen, Gerald G.; Newsome, R. W. Jr. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 161: 1050-60(Sept. 20, 1967). (LA-DC-8797).

^{4}He, ^{4}Li, and ^{4}H were produced as residual nuclear systems in various reactions induced by deuterons, tritons, and ^{3}He ions bombarding deuterium, tritium, and ^{3}He targets. The bombarding energy was varied from 12 to 22 MeV, and proton and deuteron spectra were measured at angles from 10° to 35°. The first excited state of ^{4}He was seen in the ^{3}He(d,p)^{4}He* reaction at an excitation of 20.08 ± 0.04 MeV with a center-of-mass width of 0.43 ± 0.05 MeV. It was also observed in the ^{3}He(t,d)^{4}He* reaction at an excitation of 20.00 ± 0.04 MeV with a c.m. width of 0.36 ± 0.05 MeV. There was weak evidence for a second excited state at about 1.2 MeV above the t + p mass. Upper limits on cross sections were set for possible bound states. No direct evidence for unbound states in the ^{4}Li or ^{4}H systems was observed. Both the continuous spectra and the spectral peaks are discussed and are compared with previous experimental results. Absolute cross sections were measured and are presented. (auth)

44554 SCATTERING OF HIGH ENERGY ELECTRONS AND NUCLEONS FROM ^{4}He AND NUCLEON–NUCLEON CORRELATIONS. Czyz, W.; Lesniak, L. (Inst. of Nuclear Physics, Krakow). Phys. Lett., 25B: 319-21(Sept. 18, 1967).

An attempt is made to give a coherent explanation of the recent experiments on the elastic electron and nucleon scattering from ^{4}He. (auth)

44555 ^{4}He(p,t)2p, ^{4}He(p,^{3}He)pn AND ^{4}He(p,^{3}He)d REACTIONS AT 156 MeV AND THE FINAL-STATE INTERACTION. Bernas, M.; Lee, J. K.; Bachelier, D.; Brissaud, I.; Detraz, C.; Radvanyi, P.; Roy, M. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett., 25B: 260-2(Sept. 4, 1967).

The p-n and p-p final-state interaction in the (p,^{3}He) and (p,t) reactions on ^{4}He at 156 MeV was measured for several t and ^{3}He angles and was analyzed in terms of the Watson-Migdal theory. Agreement is rather good for the shapes of the energy spectra, but not for their relative magnitudes. The differential cross section of ^{4}He + p → d + ^{3}He was measured from θ_d = 4 to 177° c.m. (auth)

44556 DEUTERON BREAK-UP BY 14.1-MeV NEUTRONS. Bruellmann, M.; Jung, H.; Meier, D.; Marmier, P. (Eidgenossiche Technische Hochschule, Zurich). Phys. Lett., 25B: 269-70 (Sept. 4, 1967).

The neutron spectra of the D(n,2n)H reaction were measured at E_n = 14.1 MeV in the range of θ_{lab} = 7.5 to 75° using the time-of-flight technique. (auth)

44557 IMPLICATIONS OF QUARK AND TRIPLET MODELS FOR HIGH ENERGY SCATTERING. van Hove, Leon (CERN, Geneva). pp 173-209 of Symmetry Principles and Fundamental Particles. Foley, Henry M.; Ruderman, Malvin A. (eds.). San Francisco, W. H. Freeman and Co., 1967.

A brief summary is given of the phenomenological behavior of

two-body collisions of hadrons at high energies, followed by a brief discussion of the problems encountered when discussing SU(3) and SU(6) symmetry for these phenomena. A more detailed presentation is devoted to the quark model approach to high energy collisions. A few relations which have been derived for the forward scattering amplitude and its imaginary part are reviewed, and more attention is given to the t dependence of the amplitude at small t and to the consistency of the basic additivity assumption. (L.B.S.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 43803, 44259, 44542, 44600, and 44657.

44558 (IS-1678) THE USE OF A 40" SCINTILLATION DETECTOR TO MEASURE (gamma,n) AND (gamma,2n) REACTIONS IN ^{19}F. Jones, Christopher Curtiss (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 204p. Dep. CFSTI.

A high-efficiency neutron detector was used with the Iowa State University electron synchrotron to measure cross sections for the production of neutrons from fluorine at energies up to 50 MeV. The 250 gallons of liquid scintillator were viewed by 28 5-in. photomultiplier tubes. The efficiency as used was 55%. Production rates for reactions in which one or two neutrons were released were computed from a least squares analysis of the probability per beam pulse for observation of k counts, where k varied from zero to nine. Integrated cross sections up to 50 MeV were considerably less than the classical dipole sum, but were generally larger than previous results. The integrated cross section out to 50 MeV for processes in which one or two neutrons are produced is 218 ± 20 MeV-mb. (auth)

44559 (ORNL-TM-1917) TEST OF DETAILED BALANCE IN THE REACTION $^{16}O(d,\alpha)^{14}N$ AND ITS INVERSE. Thornton, Stephen Thomas (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 99p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

An attempt was made to test time reversal invariance through a study of the principle of detailed balance in the reaction $^{16}O(d,\alpha)^{14}N$ and its inverse. Results are obtained which indicate that detailed balance is generally obeyed, and that there was no violation of time reversal invariance. (S.F.L.)

44560 (UCRL-17708) TEST OF TIME REVERSAL INVARIANCE IN BETA DECAY OF ^{19}Ne AND BETA DECAY ASYMMETRIES. Wick, Gerald Lee (California Univ., Berkeley. Lawrence Radiation Lab.). July 31, 1967. Contract W-7405-eng-48. 72p. Dep. CFSTI.

Thesis.

A test of time reversal (T) invariance in the beta decay of ^{19}Ne was performed. Delayed coincidences of the positron and recoil F^- ion from decays in flight of an atomic beam of nuclear spin polarized ^{19}Ne were recorded. From this information the time reversal coefficient, D, and the neutrino asymmetry coefficient, B, were determined. Since the final-state correction to D is negligibly small for this measurement, one would expect D = 0 unless T is violated. For the V-A theory of beta decay one would expect B = −1. The results obtained are: D = +0.002 ± 0.014 and B = −0.90 ± 0.13. The positron asymmetry coefficient, A, was measured by capturing polarized ^{19}Ne in a bulb and detecting counts parallel and antiparallel to the spin. There was no noticeable relaxation of the spins in this measurement. The value for this coefficient is A = −0.039 ± 0.002. It is customary to discuss the question of time reversal in terms of the phase angle, θ, between the complex vector and axial-vector coupling constants of beta decay. Time reversal invariance implies that this angle must be $\theta = 0°$ or 180°. The coefficient D is proportional to sin θ. The quadrant may be determined from A + B which is proportional to cos θ. It is found that $\theta = 180.2° \pm 1.6°$. This is consistent with T invariance. It also adds confirmation to the V-A theory of weak interactions. (auth)

44561 (UCRL-50287) EXPERIMENTAL INVESTIGATION OF PARTICULAR FINAL-STATE DECAY MODES FOLLOWING PHOTO-PARTICLE REACTIONS IN ^{16}O. Caldwell, John Thomas (California Univ., Livermore. Lawrence Radiation Lab.). May 23, 1967. Contract W-7405-eng-48. 117p. Dep. CFSTI.

Thesis.

Two independent experiments investigating particular final-state decay modes following photo-particle reactions in ^{16}O were carried out with monoenergetic photons over the giant resonance region of 17 to 29 MeV. In the first experiment, a 4π neutron detector-spectrometer was used to obtain information on ground-state and excited-state transitions in the $^{16}O(\gamma,n)$ reaction. In the second experiment, de-excitation γ rays following $^{16}O(\gamma,n\gamma'; \gamma,p\gamma'$; and $\gamma,\alpha\gamma')$ reactions were detected. By combining the results of the two experiments, a total of twelve individual decay-mode cross sections were determined, including three sets of $^{15}O-^{15}N$ mirror-level decays and the $^{16}O(\gamma,\alpha\gamma')^{12}C$ (15.1-MeV final state) reaction. Seven of these decay modes had not been observed previously, and none had been investigated with monochromatic photons. By summing up all of the ^{16}O decay cross sections determined in this experiment and adding in the $^{16}O(\gamma,p)^{15}N$ ground-state cross section, a total absorption cross section was determined that agrees well with direct total absorption measurements. A total of 78 ± 8% of all decays observed up to 29 MeV are either to the $\frac{1}{2}^-$ ground state or $\frac{3}{2}^-$ third-excited states of ^{15}N and ^{15}O. This must be regarded as major evidence for the basic validity of the single-particle, single-hole theory of photoexcitations in ^{16}O. A comparison of the experimental $\frac{1}{2}^-$ and $\frac{3}{2}^-$ cross sections with recent detailed particle-hole calculations indicates reasonable agreement between theory and experiment. The present data indicate that an elaboration of this theoretical work to include only a few specific two-particle, two-hole configurations might result in still better agreement and provide for other than $\frac{1}{2}^-$ and $\frac{3}{2}^-$ state decay modes. Of the total transition strength up to 29 MeV, 15% is divided between the $(\frac{1}{2}^+, \frac{3}{2}^+)$ and $\frac{3}{2}^+$ ^{15}O and ^{15}N final-state decays. The pairs of mirror-level decays were used to determine the T = 0 isobaric spin impurity in giant resonance states of ^{16}O. The average T = 0/T = 1 amplitude ratio is in the neighborhood of 0.08 over the entire giant resonance, but considerable structure does occur, with maximum values at excitation energies of 20.1, 22.4, 25.3, 27.3, and ≥28.3 MeV. The ratios of specific decay-mode cross sections to the total absorption cross section reveal a strong variation of σ_i/σ total absorption over the giant resonance. These ratios should be quite helpful in determining future steps to be taken in ^{16}O shell-model calculations. The $^{16}O(\gamma,\alpha\gamma')^{12}C$ (15.1 MeV, T = 1, $J^\pi = 1^+$) reaction apparently proceeds through just the single 25.2-MeV state of ^{16}O. A width of 1.4 MeV, T = 1, and J^π probably 1^- or 1^+ were determined for the 25.2-MeV state from this cross-section data. There is an indication of a strong configurational relationship between the 15.1-MeV ^{12}C and 25.2-MeV ^{16}O states. (auth)

44562 (ZFK-122, pp 71-94) NUCLEAR REACTIONS ON LIGHT NUCLEI. Hodgson, P. E. (Oxford Univ. (England). Nuclear Physics Lab.).

The application of the optical model to nuclear reactions is extended to the region of light nuclei at low energies. Optical potentials used in optical-model and distorted-wave calculations on proton and deuteron reactions with ^{10}B, ^{11}B, ^{12}C, ^{14}N, and ^{25}Mg are tabulated, and curves of calculated differential cross sections are presented. (S.F.L.)

44563 (ZFK-122, pp 111-18) IDENTIFICATION OF ENERGY LEVELS OF LIGHT NUCLEI FROM CROSS SECTIONS OF DISINTEGRATIONS. Jibuti, R. I.; Mamasakhlisov, V. I.; Macharadze, T. S. (Akademiya Nauk Gruzinskoi SSR. Institut Fiziki).

The $^7Li(\gamma,^3He)^4He$ reaction is investigated, taking into account interaction of the products of decay. It is shown that an appreciably large value of the cross section of photodisintegration of the ^7Li nucleus in the region in front and after the peak on the curve of the cross section corresponding to the state with the energy of 4.63 MeV is explained not by the existence of the corresponding levels in the nucleus but by direct transitions into a continuous spectrum. (S.F.L.)

44564 (ZFK-122, pp 156-60) UNTERSUCHUNG VON BERYLLIUM MIT POLARISIERTEN NEUTRONEN AUS DEM ENERGIEBEREICH 2,60 BIS 2,77 MeV. (Study of Beryllium with Polarized Neutrons in the Energy Range 2,60 to 2,77 MeV). Schirmer, G. (Technische Universitaet, Dresden (East Germany). Institut fuer Experimentelle Kernphysik). (In German).

The polarization of neutrons scattered on ^9Be was measured at 50° for neutron energies from 2.6 to 2.77 MeV. It varies in this interval very strongly with energy. This effect is caused by two neutron scattering resonances at about 2.73 and 2.85 MeV, corresponding to levels in ^{10}Be at 9.27 and 9.4 MeV. The experimental result is in good agreement with assigned values for spin and parity $J^\pi = 4^-$ (l = 2) and 2^+ (l = 1), respectively. (auth)

44565 (ZFK-122, pp 161-6) OPTICAL MODEL ANALYSES ON $^{12}C(d,d)$ ELASTIC SCATTERING DATA IN THE DEUTERON ENERGY RANGE FROM 10,6 TO 13,9 MeV. Baldeweg, F.; Bredel, V.; Guratzsch, H.; Klabes, R.; Kuehn, B.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

Deuteron elastic scattering on ^{12}C was investigated in connec-

tion with the $^{12}C(d,p)$ reaction at eight energies from 10.6 to 13.9 MeV. Optical-model analyses were attempted in order to determine optical parameters for distorted wave calculations. (S.F.L.)

44566 (ZFK–122, pp 169-75) ELASTIC SCATTERING OF ^{11}B ON ^{11}B IN THE ENERGY RANGE FROM 3 TO 15 MeV (CM). Guenther, G.; Schubert, K. R. (Heidelberg Univ. (West Germany). Zweites Physikalisches Institut. Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)).

Measurements of the elastic scattering of ^{11}B on ^{11}B were performed to see if the quasimolecular reaction mechanism holds for this reaction. The Heidelberg Tandem van de Graaff accelerator provided the boron beam and the incident energy was varied from 3 to 15 MeV. (S.F.L.)

44567 (ZFK–122, pp 195-200) ANGULAR DISTRIBUTION OF NEUTRONS FROM THE REACTION $^{7}Li(d,n)^{8}Be$ AT 11.7 MeV. Juna, J.; Konecny, K. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu).

The angular distribution of neutrons from the $^{7}Li(d,n)^{8}Be$ was measured for incident energies of 700 and 800 KeV. At 700 KeV, expressive asymmetry of the angular distribution, which nearly disappeared at 800 KeV, was observed. This property of the reaction is explained by interference of two levels of the compound nucleus ^{9}Be with opposite parities. (S.F.L.)

44568 (ZFK–122, pp 201-6) WECHSELWIRKUNG VON 14-MeV-NEUTRONEN MIT ^{10}B. (Interactions of 14-MeV Neutrons with ^{10}B). Goetz, G.; Mittenbacher, J.; Prager, R.; Muehle, R. (Jena Univ. (East Germany). Technisch-Physikalisches Institut). (In German).

Measurements of the reactions of 14-MeV neutrons with ^{10}B, especially the reaction $^{10}B(n,d)^{9}Be$, were evaluated. Nuclear emulsions were used in the study. The differential cross sections of the reaction $^{10}B(n,d)^{9}Be$ for transition to the ground state and to the 2.43-MeV level of ^{9}Be are presented. A pick-up process was calculated as the reaction mechanism and the results agreed with experimental values. (M.C.G.)

44569 (ZFK–122, pp 216-21) DEUTERON INDUCED REACTIONS ON ^{10}B. Baehr, K.; Fitz, W.; Jahr, R.; Santo, R. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West (Germany)).

The reactions $^{10}B(d,^{3}He)^{9}Be$ and $^{10}B(d,t)^{9}B$ were investigated at a deuteron energy of 11.8 MeV using the external beam of the Heidelberg cyclotron. The reactions were compared for symmetric results, since ^{9}Be and ^{9}B are mirror nuclei and so are t and ^{3}He. A DWBA analysis was applied to the angular distributions to extract spectroscopic factors. (S.F.L.)

44570 (ZFK-122, pp 222-6) THE REACTIONS $^{10}B(d,p_0)^{11}B$ AND $^{10}B(d,t_0)^{9}B$ AT E_d = 13.5 MeV. Barz, H. W.; Fuelle, R.; Netzband, D.; Reif, R.; Schlott, K.; Slotta, J.; Tesch, S. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The (d,p) and (d,t) reactions on ^{10}B leading to the ground states of the ^{11}B and ^{9}B nuclei are discussed. The reactions were analyzed using Butler and Dar theory and a DWBA fit, with a one-particle stripping model. The angular distributions of both reactions in absolute units were measured at E_d = 13.5 MeV using a cyclotron. (S.F.L.)

44571 (ZFK–122, pp 228-34) AN INVESTIGATION OF THE REACTION $^{12}C(d,p)^{13}C$ IN THE ENERGY REGION FROM 9 TO 14 MeV. Baldeweg, F.; Bredel, V.; Guratzsch, H.; Klabes, R.; Kuehn, B.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The reaction $^{12}C(d,p)^{13}C$ in the energy region from 9.2 to 13.9 MeV in steps of about 0.5 MeV is discussed. This investigation is part of a general investigation of the ^{12}C + d interaction. (S.F.L.)

44572 (ZFK–122, pp 234-41) FURTHER INVESTIGATIONS OF THE REACTION $^{12}C(d,\alpha)^{10}B$. Baldeweg, F.; Bredel, V.; Guratzsch, H.; Klabes, R.; Kuehn, B.; Stiller, G. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The plane-wave Born approximation with exchange was applied to the $^{12}C(d,\alpha)$ reaction at energies E_d = 9.2 to 13.9 MeV to see if the theory would explain the observed angular distributions. Generally the fits were not as successful as those published for (d,α) reactions on other light-weight nuclei. An analysis using distorted waves gave better agreement with experimental data. (S.F.L.)

44573 (ZFK–122, pp 293-8) NEUTRONEN- UND GAMMA-INDUZIERTE KERNREAKTIONEN AM ^{12}C IN STILBENKRISTALLEN. (Neutron- and Gamma-Induced Nuclear Reactions on ^{12}C in Stilbene Crystals). Mittenbacher, J.; Goetz, G.; Prager, R. (Jena Univ. (East Germany). Technisch-Physikalisches Institut). (In German).

Methods were developed for investigation of neutron- or γ-induced nuclear reactions that released α particles from ^{12}C nuclei in stilbene. Pulse-height spectra and energy spectra of the alpha particles were obtained and differential cross sections for the reactions calculated. (M.C.G.)

44574 (ZFK-122, pp 299-304) EXPERIMENTAL ANALYSIS OF THE FOUR-BODY REACTION $^{9}Be(n,nn)\alpha\alpha$ AT 15 MeV. Bouchez, R.; Darves-Blanc, R.; Giorni, A.; Gondrand, J-C.; Perrin, C.; Perrin, P.; Quivy, P. (Grenoble Univ. (France). Laboratoire de Physique Nucleaire. Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

Two time-of-flight spectrometers (≃1.5 ns overall resolution and 1.50 m flight path) were used to measure the energy of both neutrons from the reaction $^{9}Be(n,2n)2\alpha$ at angles 30–30°, 30–15°, and 80–80° using an incident neutron energy of 15 MeV. It was found that the reaction proceeds mainly through $^{8}Be(0^+)$ (≃50%) and $^{8}Be(2^+)$ (≃50%). The three-body reaction $^{9}Be(n,2n)^{8}Be^*$ is a two-step process consisting of inelastic scattering $^{9}Be(n,n')^{9}Be^*$, and neutron decay $^{9}Be \rightarrow {}^{8}Be^* + n$ or α-decay $^{9}Be^* \rightarrow {}^{5}He^* + \alpha$ (≃10%). The 6.76-, 7.94-, and 9.1-MeV levels of ^{9}Be were observed, but not the 4.7-MeV level. The 7.9-MeV level goes mainly to $^{8}Be(0^+)$, and the 9.1-MeV level to $^{8}Be(2^+)$. The width of the two-particle resonance $^{8}Be(2^+)$ ($\Gamma \simeq 2$ MeV) is shifted by the third particle, giving $\Gamma \simeq 1.2$ MeV. (S.F.L.)

44575 (ZFK-122, pp 305-10) PRELIMINARY RESULTS IN THE INVESTIGATION OF THE REACTION $^{14}N(n,2\alpha)^{7}Li$. Moesner, J.; Schintlmeister, J.; Schmidt, G. (Zentralinistitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The question of whether the $^{14}N(n,2\alpha)^{7}Li$ reaction is simultaneou or sequential is discussed. It is shown that most events require an interpretation of sequential decay. (S.F.L.)

44576 (ZFK–122, pp 314-21) THE LEVELS AND SPECTROSCOPIC FACTORS OF THE ^{18}O AND ^{20}O NUCLEI IN THE SU_3 SCHEME. Trlifaj, L.; Gmitro, M.; Sotona, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu).

The SU_3 model is used in finding the lowest states of the ^{18}O and ^{20}O nuclei. The levels and the spectroscopic factors are calculated and the residual interaction is described by a mixture of two-body Gaussian potentials and by a single-particle spin-orbit interaction. (auth)

44577 (ZFK–122, pp 354-9) PROJECTED HARTREE–FOCK SPECTRA IN LIGHT NUCLEI. Bassichis, W. H.; Giraud, B.; Ripka, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Energy levels of ^{20}Ne, ^{19}F, ^{18}F, and ^{18}O are obtained by a two-step calculation. An intrinsic state of a nucleus is described by a Hartree-Fock determinant. It consists of an inert spherical core of ^{16}O, plus a certain number of particles in the s and d shells and holes in p shell. The particles and holes are put in deformed orbitals. Then nuclear states of good angular momentum are obtained by projecting the intrinsic state of a definite eigensubspace of the angular momentum. Thus every intrinsic state gives rise to a complete rotational band and a description can be given of the rotational excited bands for which no cranking formula exists. (S.F.L.)

44578 NUCLEAR RADII OF ^{16}O AND ^{18}O. Daniel, H.; Poelz, G.; Schmitt, H.; Backenstoss, G.; Koch, H.; Charalambus, St. (CERN, Geneva). Z. Phys., 205: 472-5(1967).

The muonic 2p–1s transitions in ^{16}O and ^{18}O were measured with a Ge detector, with the 3d–2p transitions of Cl as a reference line. The rms radii of ^{18}O and ^{16}O differ by 3.5 ± 0.8% as compared with 4.0% according to the $A^{\frac{1}{3}}$ law. (auth)

44579 FOUR-PARTICLE DISINTEGRATION OF NITROGEN BY FAST NEUTRONS. Moesner, J.; Schmidt, G.; Schintlmeister, J. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Nucl. Phys., A103: 238-40(1967).

With a cloud chamber, the three-particle reaction $^{14}N(n,2\alpha)^{7}Li$ was studied at E_n = 14.1 and 15.7 MeV. The measured cross section at 14.1 MeV, $\sigma_3(14.1) = 58 \pm 12$ mb, was used to calculate $\sigma_3(15.7) = 70 \pm 15$ mb. At E_n = 15.7 MeV, 1127 events of the reaction $^{14}N(n,2\alpha)^{7}Li$ and 13 events of the four-particle reaction $^{14}N(n,t)3\alpha$ were observed in one series of pictures; thus $\sigma_4(15.7) = 0.8 \pm 0.5$ mb. The predominant disintegration modes are given. (auth)

44580 EXPERIMENTAL STUDY ON THE EXCITED STATES IN ^{6}Li NUCLEUS. Hirabayashi, Hiromi (Tokyo Inst. of Tech.). Tokyo Kogyo Daigaku Gakuho, No. 76, 159-63(Mar. 1967).

The photodisintegration of ^{6}Li irradiated with 15.7-MeV bremsstrahlung was investigated by means of nuclear emulsions. An eminent yield of photoprotons with energies below 2 MeV was observed. This yield would be interpreted to have partly arisen

from the ^{6}Li(γ,np)^{4}He reaction through the states near 9 MeV in the ^{6}Li nucleus. The photoprotons with energies above 2 MeV seemed to be caused mainly from the ^{6}Li(γ,p) reaction. The integrated cross section was estimated. The photoproton yield was calibrated with the one from the ^{2}H(γ,p) reaction under the same experimental conditions. Discussions on the reaction mechanisms are given. An analysis on the low-energy photoproton spectrum from a finite thickness target is also given. (NSA of Japan)

44581 THE (α,d)-REACTIONS OF THE BORON ISOTOPES. Al'-Dzhauakhiri, A. U., Spasskii, A. V.; Teplov, I. B.; Fateeva, L. N. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 248-51(Aug. 1967). (In Russian).

Angular distributions were measured for the deuteron groups d_0 and d_1 from the ^{10}B(α,d)^{12}C reaction at the energies of α-particles E_α = 25.0, 23.0 and 21.2 MeV and of the d_0 group from the ^{11}B(α,d)^{13}C reaction at E_α = 25.0 and 23.0 MeV. The differential excitation curves were measured for the ^{10}B(α,d)^{12}C reaction at the lab. system angles $\theta_{l.s.}$ = 30, 60, 90° (d_0) and 60° (d_1), and for the ^{11}B(α,d)^{13}C reaction at $\theta_{l.s.}$ = 60°. The qualitative analysis suggests that the two-nucleon stripping is the dominating mechanism of the reactions in view. (auth)

44582 THE STUDY OF (d,α) AND (p,α) REACTIONS ON ^{9}Be NUCLEI. Dolinov, V. K.; Melikov, Yu. V. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 2, 116-117(Mar.–Apr. 1966). (In Russian).

The reactions (d,α) and (p,α) on ^{9}Be nuclei were studied using 130-μg/cm^{3}-thick beryllium targets bombarded by deuterons and protons accelerated in a cyclotron to 12.4 and 6.2 MeV, respectively. Graphs are given of the angular distribution of α particles from the reaction ^{9}Be(d,α)^{7}Li corresponding to the formation of finite ^{7}Li nucleus in the first (0.48 MeV) and second (4.63 MeV) excited states at deuteron energies of 11.4 and 12.4 MeV. Angular distribution of α particles in the reaction ^{9}Be(p,α)^{6}Li corresponding to the first and second excited (2.18 MeV) states of ^{6}Li are also given. The absolute magnitudes of differential cross sections were determined with an error of the order of ±20%. (R.V.J.)

44583 M2 TRANSITIONS IN NUCLEI. Kurath, Dieter; Lawson, R. D. (Argonne National Lab., Ill.). Phys. Rev., 161: 915-24(Sept. 20, 1967).

A survey of experimental data about M2 transitions between low-lying nuclear states shows that the great majority of transitions in nuclei with A > 30 is severely inhibited. For heavy nuclei with a permanent deformation, the inhibition can be ascribed either to K forbiddenness or to an asymptotic selection rule. Even when a permanent deformation is not present, the effect of this selection rule may persist, and it can lead to M2 transitions whose lifetimes are several hundred times the single-particle estimate. In light nuclei, some transitions are inhibited by an isobaric-spin effect. Theoretical values are obtained for comparison with some recently measured M2 lifetimes in the region around A = 40. Both quadrupole deformation and the isobaric-spin effect can contribute to inhibitions in this region. The isobaric-spin effect is sufficient to account for the lifetimes in ^{39}K and ^{41}Ca. For nuclei further removed from ^{40}Ca, the effect of deformation is also necessary. In some simple examples it is shown that such a trend results from the nature of the particle-hole interaction. (auth)

44584 ^{19}F(d,n)^{20}Ne REACTION FROM 2.5 TO 6.5 MeV. Barrows, A. W. Jr.; Gabbard, F.; Weil, J. L. (Univ. of Kentucky, Lexington). Phys. Rev., 161: 928-34(Sept. 20, 1967).

The excitation functions of the ground- and first-excited-state neutron groups from the reaction ^{19}F(d,n)^{20}Ne were measured at laboratory angles of 0° and 30° in the deuteron energy range of 2.5 to 6.5 MeV with energy steps of about 80 keV. In general, the fluctuations observed in the excitation functions are relatively small. The angular distributions of both neutron groups were also measured at 3.062, 3.554, 3.851, 4.400, 4.938, 5.601, and 6.065 MeV. The ground-state group peaks strongly at 0° for energies above 4 MeV, while the first-excited-state group peaks at 30° for all energies, as expected from stripping theory for the known spins and parities of the levels of ^{20}Ne. The angular distributions measured at incident energies above 4.4 MeV were fitted by distorted-wave Born approximation calculations. The spectroscopic factors determined in this way vary by approximately a factor of 2, becoming larger at the higher energies. The energy-averaged value of the spectroscopic factor for the ^{20}Ne ground state is found to be 0.40, and that for the first-excited state is 0.38. When compared with the predictions of various nuclear models, these values are found to be in agreement with the hypothesis that ^{20}Ne is a deformed nucleus. (auth)

44585 NEUTRON AND PROTON SPECTRA FROM TARGETS BOMBARDED BY 160-MeV PROTONS. Wachter, J. W.; Burrus, W. R.; Gibson, W. A. (Oak Ridge National Lab., Tenn.). Phys. Rev., 161: 971-81(Sept. 20, 1967). (ORNL-TM-1781).

Secondary-neutron spectral data in the energy range between 50 and 160 MeV from targets bombarded by 160-MeV protons were measured using a proton-recoil spectrometer. Secondary-proton measurements were also made using this spectrometer. The target materials were water, deuterium, Be, C, Al, Cu, Co, and Bi; and measurements were made at 0, 10, 45, 60, and 135 deg. Target thicknesses ranged from thin targets in which the primary beam lost only a small amount of energy to thick targets in which the primary beam was completely stopped. The thin-target measurements are expressed as cross sections, and the remainder of the results are expressed as yields. Energy resolutions of 25 and 15% are associated with the neutron and proton spectra, respectively. The results are compared with theoretical results obtained from Monte Carlo nuclear-cascade codes. (auth)

44586 MIGDAL'S QUASIPARTICLE MODEL AND PARTIAL MUON CAPTURE IN ^{16}O. Rho, Mannque (Univ. of Virginia, Charlottesville). Phys. Rev., 161: 955-70(Sept. 20, 1967).

By means of the process involving the capture of muons in ^{16}O (g.s.) leading to definite final states in ^{16}N, the quasiparticle model of nuclear structure developed by Migdal and the pseudoscalar coupling generated by the axial-vector coupling in the effective weak-interaction Hamiltonian are examined. The basic assumptions essential for the quasiparticle model and the connection between this model and other better-known (nuclear) models is clarified. It is shown that the Migdal model successfully eliminates the well-known discrepancy between theory and experiment in $\mu^- + {}^{16}O(0^+) \rightarrow \nu_\mu + {}^{16}N(2^-)$ and also in $e^- + {}^{16}O(0^+) \rightarrow e^- + {}^{16}O^*(2^-)$. This in turn enables one to make use of the nuclear model to obtain a reasonable estimate of $C_P = m_\mu F_P/F_A$. The conclusion is that the one-pion-pole dominance hypothesis is compatible with all available data in ^{16}O and that there seems to be no urgent need to introduce the tensor coupling as some people have suggested. (auth)

44587 ^{14}N(^{14}N,^{13}N)^{15}N REACTION AT LOW ENERGIES AND THE ELASTIC SCATTERING OF ^{14}N BY ^{14}N. Breit, G.; Polak, J. A.; Torchia, D. A. (Yale Univ., New Haven). Phys. Rev., 161: 993-1005(Sept. 20, 1967). (YALE-1807-44).

The molecular-viewpoint form of nucleon tunneling theory is used in the two-level approximation and with neglect of the dynamic reaction terms for a partial-wave analysis allowing the inclusion of the effects of wave function absorption through the use of an imaginary part of the potential. The equations are used in an analysis of improved measurements of the differential and total cross sections of the reaction ^{14}N(^{14}N,^{13}N)^{15}N, with special attention to laboratory energies $E_l \leq 16$ MeV which are below the Coulomb barrier. At the lowest energies, the analysis involves only the Coulomb interaction between the heavy particles. Fits to data are improved at the higher energies through the introduction of optical potentials. The principal function of these in the present work is to modify the wave function at distances larger than those corresponding to definite contact between ^{14}N and ^{14}N. The transfer function $\beta(R)$ is cut off at small values of the internuclear distance R to avoid the inclusion of unrealistic contributions to neutron transfer when the two nuclei are no longer distinct. The potential has been adjusted for best fits to neutron-transfer data. The long distance tail of the potentials tried was made to agree, regarding relative values at different distances, with that calculated by McIntosh, Rawitscher, and Park in their work on the elastic scattering of ^{14}N by ^{14}N, and depends therefore on nucleon-nucleus scattering information. The potentials were adjusted to represent the elastic-scattering ^{14}N + ^{14}N data simultaneously with neutron-transfer data. These combined requirements are met best by potentials referred to as 2 and 3 in the text. The reduced width of the transferred neutron obtained from transfer data depends on the potential only weakly. The same reduced width from elastic-scattering information is sensitive to the choice of potential. The best agreement of the elastic-scattering and neutron-transfer reduced widths is obtained for potential 3, the disagreement being less than by a factor 2. The combined uncertainty of the two ways of arriving at the reduced width is believed to be large and to make the discrepancy insignificant. The combined treatment of neutron transfer and of elastic scattering is self-consistent in the sense described. The neutron transfer reduced width is slightly smaller than the single-particle reduced width calculated with the nucleon-nucleus potential employed in obtaining the proportionality constant of the long-distance nucleus-nucleus potential tail. (auth)

44588 PRODUCTION OF PROTONS, DEUTERONS, AND TRITONS FROM ^{6}Li ON ^{7}Li AT 3.5 MeV. Gale, Douglas S.; Blair, J. M. (Univ. of Minnesota, Minneapolis). Phys. Rev., 161: 1061-3(Sept. 20, 1967).

Angular distributions of four groups of protons, four groups of deuterons, and one group of tritons were obtained from the bombardment of ^{7}Li on ^{6}Li at an incident energy of 3.50 MeV. The observed distributions differ appreciably from earlier observations at 2.1 MeV. (auth)

44589 LOWEST 4^+ LEVEL IN ^{12}C: AN EXAMPLE OF NUCLEAR SPECTROSCOPY WITH NUCLEON-CLUSTER TRANSFER REACTION. Ui, Haruo (Duke Univ., Durham, N. C.). Phys. Rev., 161: 1099-1106(Sept. 20, 1967).

The intermediate-coupling shell model predicts a level with spin 4^+ in ^{12}C at excitation energy of about 12 MeV, its main configuration being $p^8[44]^{11}G$. Experimental evidence for this level is limited at present to observation only in $^{12}C-^{12}C$ inelastic scattering. In order to investigate further possibilities for observing this level, nuclear direct interactions with various nucleon-cluster transfers are examined in detail. In particular, the spectroscopic-factor amplitudes in the deuteron reduced width for the ground state of ^{14}N leading to all the available p^8 configurations of ^{12}C are calculated by making use of the harmonic-oscillator shell model; it is found that the spectroscopic factor leading to $[44]^{11}G_4$ is quite large. Direct-interaction mechanisms are discussed in some detail, mainly from the kinematical standpoint (i.e., pology), and partly from the standpoint of nuclear-cluster structure. As a result, it is conjectured that the $^{14}N(d,\alpha)^{12}C$ reaction will proceed predominantly through the transfer process. It is then concluded that the lowest 4^+ level of ^{12}C could be most easily observed in the $^{14}N(d,\alpha)^{12}C$ reaction at higher energy (~15 to 20-MeV deuterons). (auth)

44590 EXCITATION OF VARIOUS LEVELS OF ^{12}C AND ^{16}O BY 156-MeV PROTONS. Lee, H. K. (Duquesne Univ., Pittsburgh); McManus, H. Phys. Rev., 161: 1087-98(Sept. 20, 1967).

The cross sections and polarizations for the final states 1^-, 1^+, 2^-, 2^+, and 3^- of ^{12}C and 1^-, 2^-, and 3^- of ^{16}O are calculated using the Gillet vectors and the WKB method with the impulse approximation. The WKB method is found to work very well compared with the distorted-wave impulse approximation. Surprisingly good agreement is reached with cross-section data for most cases. Agreement with polarization data is poor. There exists a striking correlation between inelastic electron and proton scattering. (auth)

44591 ELASTIC SCATTERING OF DEUTERONS FROM ^{14}N BETWEEN 1.8 TO 5.5 MeV. Flinner, J. L.; Harris, J. C.; Mulligan, B. (Ohio State Univ., Columbus). Phys. Rev., 161: 1082-6(Sept. 20, 1967).

The elastic scattering of deuterons by ^{14}N was investigated for incident energies from 1.8 to 5.5 MeV. Excitation curves were measured at 90.0°, 125.3°, 140.8°, and 166.6° (c.m.), and all but the 90° curve showed broad fluctuations. Peaks which appeared at more than one angle were considered to be resonances, and energy levels in ^{16}O were determined from them. Angular distributions from 18 to 166° (c.m.) were measured in 500-keV steps from 2 to 5.5 MeV, and optical-model analyses of these data were made both with volume absorption and with surface absorption. The surface-absorption calculations were best, and one such set of parameters was found which gave reasonable fits for the angular distributions at all energies. An optical-potential ambiguity appeared in the analysis of these data. The total reaction cross section at 3 MeV was found to be 947 mb ±20% experimentally, and this value was compared with the theoretical value of 921 mb determined from the parameters referred to above. (auth)

44592 PRECISION DETERMINATION OF THE $^{12}C-^{13}C$ NEUTRON SEPARATION ENERGY. Prestwich, W. V.; Cote, R. E.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev., 161: 1080-2(Sept. 20, 1967).

The neutron separation energy for the $^{12}C(n,\gamma)^{13}C$ reaction was determined by observing the γ-ray transitions with a Ge(Li) detector. The energy of each transition was determined relative to an appropriate precision standard. The value obtained, 4946.47 ± 0.17 keV, is in good agreement with previous values and represents a significant improvement in precision. (auth)

44593 (n,p) AND (n,d) REACTIONS AT 152 MeV. Measday, David F. (Harvard Univ., Cambridge, Mass.); Palmieri, J. N. Phys. Rev., 161: 1071-9(Sept. 20, 1967).

The (n,p) reaction on the nuclei ^{6}Li, ^{7}Li, ^{9}Be, ^{12}C, ^{27}Al, ^{40}Ca, and ^{51}V was studied at 152 MeV. The ground-state transition is clearly detected for ^{6}Li, but is not resolved for the other nuclei. In all nuclei, a strong excitation with a Q value of about –25 MeV is reported. This is interpreted as an excitation of giant collective multipole resonances. In the lightest elements there is also strong evidence for quasielastic scattering for angles around 20°. Comparisons are made with the medium-energy (p,n) and (p,p′) reactions. Some results are also reported for the (n,d) reaction on ^{6}Li, ^{7}Li, and ^{12}C. (auth)

44594 NONELASTIC CROSS SECTIONS OF NUCLEI FOR 14.8-MeV NEUTRONS. Chatterjee, Arun; Ghose, A. M. (Bose Inst., Calcutta). Phys. Rev., 161: 1181-4(Sept. 20, 1967).

Nonelastic cross sections of nuclei for fast neutrons were measured by using a new method of analysis for the conventional sphere-transmission data. The multiple-scattering correction was made by a simple polynomial extrapolation formula, while the error caused by energy loss in elastic collisions was corrected by the two-bias method developed by the authors. The latter method enables one to measure inelastic neutrons in the presence of elastic neutrons, without any loss in relative efficiencies. For other minor errors, corrections were made in the usual way. The nonelastic cross sections for 14.8-MeV neutrons of C, O, Al, Cu, Cd, Sn, Ce, W, and Pb nuclei were measured, respectively, as 0.55 ± 0.02, 0.85 ± 0.04, 0.94 ± 0.03, 1.46 ± 0.03, 1.85 ± 0.04, 1.91 ± 0.04, 2.03 ± 0.08, 2.44 ± 0.06, 2.50 ± 0.05 b/nucleus. The results were interpreted in terms of local and nonlocal optical models. (auth)

44595 ENERGY DEPENDENCE OF $^{26}Mg(p,t)^{24}Mg$ AND $^{12}C(p,t)^{10}C$ L = 0 AND L = 2 ANGULAR-DISTRIBUTION SHAPES. Cosper, S. W.; Brunnader, H.; Cerny, J.; McGrath, L. (Univ. of California, Berkeley). Phys. Lett., 25B: 324-7(Sept. 18, 1967). (UCRL-17709).

Through (p,t) angular distributions with L = 0 and 2 normally show a static behavior, their measurement on ^{26}Mg and ^{12}C targets for proton energies between 20 and 54 MeV shows a marked shape and magnitude deterioration at the lower energies. These results are compared to two-nucleon transfer DWBA theory. (auth)

44596 A HIGH-RESOLUTION STUDY OF THE $^{16}O(\gamma,p_0)^{15}N$ REACTION. Thompson, M. N.; Baglin, J. E. E. (Yale Univ., New Haven). Phys. Lett., 25B: 256-8(Sept. 4, 1967).

High-resolution spectra of photoprotons from ^{16}O were measured at 45, 90, and 120°. They reveal a more complex cross section than previously anticipated, with structures of widths as small as 50 keV. (auth)

44597 DEPOLARIZATION EFFECTS DURING CHARGE EXCHANGE OF A POLARIZED TANDEM BEAM. Clausnitzer, G.; Duerr, W.; Fleischmann, R.; Graw, G.; Salzborn, E.; Witte, J. (Univ., Erlangen, Ger.). Phys. Lett., 25B: 267-9(Sept. 4, 1967).

Asymmetry measurements of elastically scattered protons from ^{12}C were used to determine the degree of polarization of the Erlangen polarized proton beam. Depolarization effects during charge exchange were investigated. (auth)

44598 ANGULAR CORRELATION STUDIES OF EXCITED STATES IN ^{11}C AND ^{14}N. Blake, R. S.; Paul, E. B.; Sinex, C. H.; Emerson, S. T. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A102: 305-21(1967). (ORO–1316-18(Rev.)).

Alpha–gamma angular correlations in the reaction $^{12}C(^3He,\alpha\gamma)^{11}C$ lead to the most probable assignments of $J = \leq 5/2$, $5/2$, and $3/2$ for the states at 2.00, 4.32, and 4.81 MeV, respectively. The 4.81-MeV state was observed to decay to the 2.00-MeV state and the ground state with branch intensities of 16 ± 3% and 84 ± 3%, respectively. Proton–gamma angular correlations in the reaction $^{12}C(^3He,p\gamma)^{14}N$ reconfirmed that the spin of the 7.03-MeV state is 2. A 2 ± 1% decay to the 3.95-MeV state is reported. In the 8.95-MeV state, gamma-ray decay competes successfully with proton emission. It decays only to the 6.44-MeV state. The angular correlation of the resulting 2.51-MeV gamma ray may be reconciled with the spin of the 8.95-MeV state being ≤5. Reasonable arguments show that 5^+, 4^+, or 3^+ are the most probable values. (auth)

44599 FLUCTUATIONS IN THE $^{12}C(^{16}O,\alpha)^{24}Mg$ REACTION. Drysdale, N.; Phillips, W. R.; Policarpo, A. J. P. L. (Univ. of Manchester, Eng.). Nucl. Phys., A102: 337-62(1967).

The reaction $^{12}C(^{16}O,\alpha)^{24}Mg$ leading to the ground and first six excited states of ^{24}Mg was studied over the oxygen bombarding energy range 24.3 to 27.7 MeV. Angular distributions were measured at seven bombarding energies and detailed excitation functions for the production of the α-particles were measured at angles of observation of 15°, 35°, and 55°. The cross sections fluctuate and values of the fluctuation width were computed. Angle and channel correlation functions were calculated and the results compared with the statistical theory. This theory adequately describes the observed features of the reaction without inclusion of any direct component in the reaction amplitude. (auth)

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Refer also to abstracts 42964, 43253, 43803, 44280, 44542, 44577,

44585, 44593–44595, 44658, 44663, 44667, 44677, 44686, 44736, 44796, and 44805.

44600 (ORNL-TM-1991) SOME RECENT NUCLEAR CROSS SECTION MEASUREMENTS AT ORNL, APRIL 1, 1967–SEPTEMBER 30, 1967. Stelson, P. H. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 18p. Dep. CFSTI.

Measurements were made of neutron elastic and inelastic differential cross sections on C, Mg, Al, Si, S, Fe, Co, and Y at 7.6 MeV. Also reported are total cross sections for neutron elastic and inelastic scattering by ^{56}Fe at 4.60 to 7.55 MeV and gamma-ray spectra from neutron inelastic scattering by ^{14}N at 6.0 to 8.4 MeV. (S.F.L.)

44601 (UCRL–17788) BREMSSTRAHLUNG ACTIVATION OF ISOMERS. Louie, William Nom Hing (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 36p. Dep. CFSTI.

Thesis.

A search was performed for isomers with half-lives in the millisecond range which could be excited with bremsstrahlung produced by 6.5-MeV electrons from a linear accelerator. Previous work in this energy range had been limited to isomers with half-lives longer than one second. In-place counting was used with a plastic scintillator as the detector. Counting was done between beam pulses, with the detector circuit gated off during the beam burst. A gating circuit was designed for this purpose using silicon controlled rectifiers as the main control elements. One isomer in the millisecond range, 17 msec ^{75m}As, was found out of the sixty-four elements bombarded. Over-driving effects caused by the strong bremsstrahlung flash prevented detection in the very short millisecond range. In addition seven other isomers, with half-lives less than thirty seconds, were observed as follows: ^{77m}Se, 16.1 ± 0.7 sec; ^{79m}Br, 4.9 ± 0.1 sec; ^{89m}Y, 15 ± 1 sec; ^{167m}Er, 2.3 ± 0.1 sec; ^{179m}Hf, 18.8 ± 0.1 sec; ^{191m}Ir, 5.3 ± 0.3 sec; and ^{197m}Au, 7.36 ± 0.06 sec. (auth)

44602 (UJV–1596) SCATTERING OF POLARIZED PROTONS BY NEON. Bem, P.; Habanec, J.; Karban, O.; Nemec, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 17p. Dep.

The polarization and cross section in proton scattering on a neon target were measured between 3.9 and 5.1 MeV. The data were interpreted in terms of nonresonant scattering together with the resonant scattering from four states of the compound system. Spins and parities $J^{\pi} = 3/2^+$ ($5/2^+$), $1/2^+$, and $5/2^+$ could be assigned to the ^{21}Na levels at 6.52, (6.90), 7.20, and 7.45 MeV, respectively. (auth)

44603 (ZFK–122, pp 176-82) THE ^{21}Na LEVELS FROM SCATTERING OF POLARIZED PROTONS BY NEON. Bem, P.; Habanec, J.; Karban, O.; Nemec, J. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu).

The levels of the ^{21}Na compound nucleus were studied by elastic and inelastic scattering of protons by ^{20}Ne at energies up to 5.5 MeV. The analysis of the cross section anomalies in the region of 4.0 to 5.3 MeV resulted in an ambiguous determination of some level characteristics. (S.F.L.)

44604 (ZFK-122, pp 275-8) M1 TRANSITIONS IN THE ^{35}Cl(n,γ)^{36}Cl REACTION. Doenau, F.; Gersch, H. U. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The compound reaction ^{35}Cl(n,γ)^{36}Cl is studied and wave functions are calculated for the excited states. The low energy states of ^{36}Cl are approximated by Glaudemans functions. (S.F.L.)

44605 (ZFK-122, pp 249-57) THE STUDY OF THE α–γ CORRELATION FOR ^{32}S(α,α′γ$_{2.24}$) REACTION. Hulubei, H.; Ivascu, M.; Marincu, E.; Dumitrescu, R.; Seminescu, G. (Academia R. P. R., Bucharest. Institutul de Fizica Atomica).

Alpha-gamma angular correlations were measured between inelastically scattered alpha particles and de-excitation gamma rays from the reactions ^{32}S(α,α′γ). These reactions involve the excitation of the 2^+ level. Angular correlations were measured at sixteen scattering angles. The data are found to disagree with the predictions of the plane-wave Born approximation (PWBA) and the adiabatic approximation. Calculations made using the relations according to Inglis theory give good agreement with the predictions of the corresponding qualitative model. The qualitative aspects of the curves suggest an agreement with DWBA theory. (auth)

44606 (ZFK-122, pp 279-87) CROSS-SECTION FLUCTUATIONS IN (p,α) REACTIONS ON ^{26}Mg AND ^{37}Cl. Brentano, P. v.; Ernst, J.; Mayer-Kuckuk, T.; Richter, A.; Witsch, W. v. (Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany)).

The (p,α) reactions on ^{26}M, and ^{37}Cl are discussed as quantitative tests of fluctuation theory. Excitation functions and angular distributions were measured for both reactions. It was found that appropriate fluctuation analysis of these reactions is consistent with the predictions of the statistical model. (S.F.L.)

44607 (ZFK-122, pp 289-92) MESSUNGEN VON EFFEKTIVEN WIRKUNGSQUERSCHNITTEN DER PAARBILDUNG FUER DIE ISOMERE ^{58m}Co UND DEN GRUNDZUSTAND IN DEN REAKTIONEN (n,2n), (n,p), (γ,n). (Measurements of Effective Cross Sections for Pair Production for the Isomer ^{58m}Co and the Ground States in the Reactions (n,2n), (n,p), and (γ,n)). Wilhelmi, Z.; Gierlik, E.; Grochulski, W.; Decowski, P.; Marcinkowski, A.; Siwek, K.; Sledzinska, I. (Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research. Warsaw Univ. (Poland). Inst. of Experimental Physics). (In German).

Results of measurements of the isomeric ratios for the reactions ^{58}Co(n,2n)^{57}Co, ^{58}Ni(n,p)^{58}Co, and ^{59}Co(γ,n)^{58}Co were compared with the corresponding calculated scheme. Cobalt was irradiated with neutrons at 12.6 to 18.3 MeV and nickel with neutrons at 13.2 to 17.2 MeV. The reaction ^{59}Co(γ,n)^{58}Co was carried out with bremsstrahlung from electron acceleration in a 30-MeV betatron. The Fermi-Gas Model agreed better with experimental results than the Superconductivity Model. Data are presented in graphs. (M.C.G.)

44608 (ZFK–122, pp 312-13) THE EXCITED STATES OF ^{22}Na. Maier, H. J.; Pelte, D.; Pronko, J.G.; Rolfs, C. (Freiburg Univ. (West Germany). Physikalisches Institut).

The gamma decays of the excited states of ^{22}Na below 4.4 MeV excitation were studied using the ^{20}Ne(^{3}He,p)^{22}Na at an incident energy of 5.35 MeV. A special gas target of spectroscopically pure neon gas was used. (S.F.L.)

44609 (ZFK–122, pp 323-9) ATTEMPTS TO CALCULATE THE LOW-LYING STATES OF ODD PARITY IN ^{17}O. Pfitzner, A. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The cross section for elastic neutron scattering on ^{16}O up to 2 MeV incident energy exhibits, besides the $d_{\frac{5}{2}}$ single-particle resonance at 1 MeV, five strongly pronounced resonances, four of which are known to be associated with odd-parity levels of ^{17}O. To confirm that an interaction which fits the odd-parity p–h excitations in ^{16}O is too weak to fit the even parity states in ^{18}O, and therefore is not a suitable interaction in the 2p–1h configuration space which contains both p–p and p–h interactions, a shell model calculation was carried out with a central force fitting the odd-parity p–h excitations in ^{16}O. (S.F.L.)

44610 (ZFK–122, pp 330-4) PROPERTIES OF THE LOW-LYING STATES OF ^{63}Cu IN THE SINGLE PARTICLE PLUS QUASI-BOSON SCHEME. Doleschall, P.; Lovas, I. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest).

The role of the short-range component of the neutron–proton interaction is investigated for Cu isotopes. The properties of the low-lying levels in ^{63}Cu are calculated assuming quadrupole, delta, and Gaussian proton–neutron interactions. (S.F.L.)

44611 (ORNL-tr-1739) INVESTIGATION OF γ-TRANSITIONS IN THE ^{59}Co(p,nγ)^{59}Ni REACTION. Valter, A. K.; Zalyubovsky, I. I.; Klyucharev, V. O.; Lutsik, V. P. Translated for Oak Ridge National Lab., Tenn., from Ukr. Fiz. Zh., 6: 318-32(1961). 22p. Dep. CFSTI. JCL $2.60 fs, $0.86 mf.

Gamma transitions in ^{59}Ni were studied by measuring gamma spectra from the reaction ^{59}Co(p,n)^{59}Ni at 2 to 4 MeV using a scintillation spectrometer. Spin assignments were made for several energy levels of ^{59}Ni. (D.C.W.)

44612 (p,nγ) REACTION ON ^{49}Ti AND LEVEL SCHEME OF ^{49}V. Blasi, P. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Maurenzig, P. R.; Ricci, R. A.; Taccetti, N.; Giacomich, R.; Lagonegro, M.; Poiani, G. Nuovo Cim. (10), 51B: 241-6(Sept. 11, 1967).

The ^{49}Ti(p,nγ)^{49}V reaction was studied with the proton beam of the 5.6-MeV Van de Graaff accelerator of the University of Padova, in order to investigate the level structure of ^{49}V. Direct γ-ray spectra, γ–γ coincidences, and γ-ray yield in some resonance region of the compound ^{50}V nucleus were measured. The experimental spectra obtained is compared with theoretical ones derived from shell model treatment with effective residual interaction, and from Coriolis coupling in a deformed-core model. (S.F.L.)

44613 THE (t,p) REACTION WITH THE EVEN ISOTOPES OF Ca. Bjerregaard, J. H. (Univ. of Copenhagen); Hansen, Ole; Nathan, O.; Chapman, R.; Hinds, S.; Middleton, R. Nucl. Phys., A103: 33-70(1967).

The reactions ^{40,42,44,46,48}Ca(t,p) were investigated at 10- to 12-MeV bombarding energy with an overall energy resolution of 15 to 25 keV. The relative differential (t,p) cross sections for the strongest L = 0 transitions in the various isotopes were measured by means of a target composed of approximately equal

amounts of the various even Ca isotopes. The systematic trends of the (t,p) angular distribution shapes were established for angular momentum transfers of 0, 2, 3, and 4 units of ħ. A number of 0^+, 2^+, and 4^+ assignments were made. A detailed comparison of the data from the one- and two-neutron capture reactions leading to ^{44}Ca is presented, and the systematics of the 0^+ states in the Ca isotopes are discussed. Two distinct groups of 0^+ states, both characterized by large (t,p) cross sections, were observed; one group comprises the ^{42,44,48,48}Ca ground states and the second group consists of the following states: 5.85 MeV, ^{42}Ca; 5.864 MeV, ^{44}Ca; 5.595 and 5.628 MeV, ^{46}Ca; 5.459 MeV, ^{48}Ca; and ^{50}Ca (ground state). (auth)

44614 THE HIGH-ENERGY DECAY OF ^{63}Zn. De Frenne, D.; Dorikens, M.; Dorikens-Vanpraet, L.; Demuynck, J. (Rijksuniversiteit, Ghent). Nucl. Phys., A103: 203-8(1967).

Several new gamma rays were found in the spectrum of ^{63}Cu following the decay of ^{63}Zn using a Ge(Li) detector. A revised level scheme with 21 excited states is proposed. (auth)

44615 THE ENERGY LEVELS OF ^{53}Fe. Vervier, J. (Centre d'Etudes de l'Energie Nucleaire, Mol, Belg.). Nucl. Phys., A103: 222-4(1967).

The energy levels of ^{53}Fe are re-investigated in the framework of the $1f_{\frac{7}{2}}$ shell using various effective nucleon-nucleon interactions. The agreement between experiment and calculations is satisfactory and does not strongly depend on the details of the effective interactions adopted. (auth)

44616 YIELDS OF RADIOACTIVE ISOTOPES ^{22}Na, ^{54}Mn, ^{57}Co, AND ^{181}W IN NUCLEAR REACTIONS WITH PROTONS, DEUTERONS, AND ALPHA PARTICLES. Dmitriev, P. P.; Krasnov, N. N. (Physico-Energetic Inst., Obninsk, USSR). Chem. Zvesti, 21: 611-15(1967). (In Russian).

Different methods for preparation of radioactive isotopes ^{22}Na, ^{54}Mn, ^{57}Co, and ^{181}W in cyclotrons are discussed. Yields of these isotopes obtained in different nuclear reactions are given, and for each of them an optimal method of preparation is recommended. On the basis of the yields of ^{22}Na, ^{54}Mn, ^{57}Co, and ^{181}W attained in the nuclear reactions with protons, deuterons, and alpha particles, it can be concluded that for the nuclear reaction in which most favorable yields are attained, three kinds of accelerated particles are necessary: protons ($E_p \sim 20$ MeV), deuterons ($E_d \sim 20$ MeV), and alpha particles ($E_\alpha \sim 40$ MeV). (auth)

44617 INELASTIC SCATTERING OF PROTONS ON ^{27}Al AT ENERGIES NEAR 6 MeV. Antropov, A. E.; Gridnev, K. A.; Zarubin, P. P.; Orlov, B. N.; Plavko, A. V.; Khrisanov, Yu. V. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1197-1203(July 1966). (In Russian).

In view of contradictory reports in the literature concerning the lower levels of ^{27}Al, the excitation range below 2 MeV in ^{27}Al was examined by measuring the spectra of inelastically scattered 5.9-, 6.0, and 6.1-MeV protons. The proton beam extracted from a 120-cm cyclotron was focused onto the target, and the angular distribution of the inelastically scattered neutrons was measured within the range from 25 to 140°, using one-channel scintillation spectrometers as monitors. A 100-channel amplitude analyzer controlled the stability of the system. Comparison of the experimentally obtained angular distribution of inelastically scattered protons with the data of other authors indicated that within the energy range examined a certain amount of direct interaction contributes to the inelastic scattering process. The main contribution to the inelastic scattering of protons on ^{27}Al is due primarily to indirect processes and in particular to the compound-nucleus mechanism. (TTT)

44618 COULOMB EXCITATION OF LIGHT NUCLEI AT ENERGIES ABOVE THE BARRIER. Afonin, O. F.; Grinberg, A. P.; Lemberg, I. Kh. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1142-9(July 1966). (In Russian).

In order to study Coulomb excitation processes occurring with a high excitation energy, the energy of the bombarding particles must be used. In view of experimental difficulties, the γI coincidence method with a small angle of scattering was used, whereby I designates the inelastically scattered ion. Specific energy losses were reduced by using thin targets. The method was applied to the investigation of Coulomb excitation of the ^{19}F, ^{28}Si, ^{32}S, and ^{52}Cr nuclei, focusing the beam of fivefold charged ^{14}N on the thin target placed in the center of a cylindrical scattering chamber. Discharge of the ^{19}F nucleus occurred in 95.4% of the cases by cascade emission of two γ quanta with energies of 1360 and 198 keV; in the rest of the cases, the discharge occurred by emitting a 1450- and 110-keV cascade. The 1.36- and 1.45-MeV lines were not resolved. The B(E2) value of the 1.77-MeV level of ^{28}Si was found to agree with the average of 0.032 of previously reported data. In the case of ^{32}S, the earlier B(E2) data differed by more than a factor of 2; the value found was close to 0.037, representing an average of all but 2 studies. The corresponding value for ^{52}Cr agreed within experimental error with the average of other studies, save one, namely 0.055. (TTT)

44619 ANALYSIS OF ELASTIC SCATTERING OF POLARIZED 3.4 MeV NEUTRONS BY S, Cu, Zn, AND Zr NUCLEI USING AN OPTICAL NUCLEAR MODEL. Kashuba, I. E.; Korzh, I. A.; Kozin, B. D. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1343-8(Aug. 1966). (In Russian).

The differential cross-sections and polarization resulting from elastic scattering of 3-MeV neutrons by S, Cu, Zn, and Zr nuclei were analyzed by an optical model. Plots of the experimental data on cross-sections and polarization for Cu and Zn were quite similar in shape but somewhat different in value, while those for S and Zr differed also in shape. For S, Cu, and Zn the sign of the polarization for small-angle scattering corresponded to the sign of the slope of the cross-section curve, with polarization practically zero at the first minimum of the differential cross-section curve. Calculations for all nuclei show that elastic scattering by compound nuclei modifies not only the value but also the form of the calculated polarization and must be considered to obtain reasonable agreement between theoretical and experimental data. Both the experimental and calculated data showed differences existing even between nuclei of neighboring elements (Cu and Zn) and the experimental data on differential cross-section and polarization cannot be fit by a smooth collection of parameters of the optical model. (TTT)

44620 NUCLEAR RADIUS CHANGE ON THE ADDITION OF ONE PROTON. Quitmann, D. (Technische Hochschule, Darmstadt, Ger.). Z. Phys., 206: 113-30(1967). (In German).

The change of the rms radius of the nuclear charge distribution on addition of one proton is derived for 25 nuclides between $^{39}_{19}$K and $^{208}_{82}$Pb. For this purpose, results of the muonic 2p–1s transition energies are used together with the optical isotope shifts. The uncertainties of the procedure are discussed. Corresponding results from elastic electron scattering are included for three pairs of nuclides. For heavy nuclei, the average increase in radius per proton exceeds considerably that per neutron, as expected. Although the individual values are associated with rather large errors, shell effects seem to be noticeable at Z = 28 and Z = 50. (auth)

44621 BEHAVIOR OF THE (γ,xn) CROSS SECTION IN SELENIUM AND IRON. Costa, S. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Ferrero, F.; Manfredotti, C.; Pasqualini, L.; Piragino, G.; Arenhoevel, H. Nuovo Cim. (10), 51B: 199-201(Sept. 11, 1967).

The total photoneutron cross sections of Fe and Se were measured at photon energies of 12 to 24 MeV in an attempt to observe intermediate collective structure of the giant resonance. The results were compared with the predictions of the dynamical theory of the collective model. At the lower energies, the pure collective-model theory seems to be inadequate; combining the collective and particle-hole approaches would probably give better agreement between the experimental and theoretical results. (D.C.W.)

44622 INELASTIC PROTON SCATTERING BY ^{22}Ne NUCLEI. Andreev, G. B.; Deineko, A. S.; Levchenko, Yu. Z.; Malakhov, I. Ya.; Popov, A. I.; Storizhko, V. E.; Taranov, A. Ya. (Inst. of Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1396-8 (Aug. 1966). (In Russian).

The inelastic scattering of protons by ^{22}Ne nuclei was measured in the 1.9- to 3.4-MeV energy range. Forty-four resonances were observed, 16 of which had not been observed before. The resonance at 2.728 MeV reported elsewhere, probably due to impurities in the target, was not observed. The angular gamma dispersion was measured for 24 resonances, and spins and parities were determined. The experimental data were interpreted assuming that the resonance under study was related to only one level ($l \leq 5$); spin and parity for the ^{22}Ne ground state are 0^+, and of the first excited state, 2^+. Gamma transition between the two levels 2^+ and 0^+ is a pure E-2 transition. The measurements were made on a thin target of enriched ^{22}Ne obtained by packing ^{22}Ne ions in a tantalum base in a magnetic separator. (TTT)

44623 SHORT-SPACING MEASUREMENTS OF EXCITATION FUNCTIONS IN A CYCLOTRON. Vasil'ev, S. S.; Vorob'ev, Yu. A.; Mikhaleva, T. N.; Chuprunov, D. L. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1399-1403(Aug. 1966). (In Russian).

The mechanism of a nuclear reaction may be evaluated by comparing the excitation function measured through a small energy range with angular distribution data. By means of these

studies it is occasionally possible to determine the lifetime of the highly excited state of a compound nucleus or of an intermediate compound system. This approach was used in an attempt to derive the excitation function through small energy intervals in a beam of particles accelerated in the 120-cm cyclotron of the Institute for Nuclear Studies of the University, keeping the $\Delta E/E$ ratio constant throughout the whole range. Comparison of the results with literature data obtained by means of electrostatic generators concerning $^{27}Al(p,\alpha_0)^{24}Mg$, and $^{27}Al(p,\alpha_1)^{24*}$ Mg reactions showed good agreement. It was concluded that the structure of the excitation function may be determined by this method as with that involving the use of electrostatic generators. (TTT)

44624 PHOSPHORUS PHOTOPROTONS. Ishkhanov, B. S.; Kapitonov, I. M.; Seliverstova, Zh. M.; Shevchenko, V. G.; Yur'ev, B. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1385-6(Aug. 1966). (In Russian).

Photon spallation on the ^{31}P nucleus was studied with the 35-MeV betatron. The photoproton energy distribution was determined by a nuclear photoemulsion method. The target used was a natural mixture of phosphorus isotopes, which was made by precipitating powdered phosphorus on a thin organic backing (approximately 10 mg/cm^2). The proton energy spectrum had a maximum at 3 MeV for $E_{\gamma max}$ = 18 MeV. An energy distribution for $E_{\gamma max}$ = 34 MeV agreed with published values. This spectrum had a wide maximum in the region around E_p = 4 MeV, with a smooth drop to zero at 7 MeV. It is concluded that the limits of the energy distribution for irradiation with $E_{\gamma max}$ = 34 MeV is significantly lower than the kinematic limit (25.8 MeV). In the photon spallation of ^{31}P nuclei by gamma quanta of 25 to 30 MeV energy, the final nucleus is in the excited state with an excitation energy greater than 5 MeV. (TTT)

44625 NEW DETERMINATION OF THE NUCLEAR GYROMAGNETIC RATIO γ OF ^{59}Co. Walstedt, R. E. (Bell Telephone Labs., Murray Hill, N. J.); Wernick, J. H.; Jaccarino, V. Phys. Rev., 162: 301-11(Oct. 10, 1967).

The nuclear gyromagnetic ratio γ of ^{59}Co was redetermined from NMR studies of the intermetallic compounds CoSi and $CoSi_2$, yielding the value $\gamma/2\pi = 1.0054 \pm 0.002$ kHz/G. These materials possess weak dia- and paramagnetism, respectively. The analysis consists of placing upper limits on the NMR shifts in these compounds by using measured values of susceptibilities and spin–lattice relaxation times T_1 and the well-known relations between shift and susceptibility contributions from orbital and spin–paramagnetic sources. The findings reported are further supported by shifts observed for dilute cobalt in a number of transition-metal alloys. The value of γ given above is larger by ~0.9% than the commonly accepted one of Freeman, Murray, and Richards that was obtained by extrapolation in their study of NMR shifts and optical splittings in cobalt complexes. In view of this discrepancy, the theory of Van Vleck shifts in these complexes is reexamined in terms of a molecular orbital model of covalent mixing. (auth)

44626 INVESTIGATION OF THE COULOMB EXCITATION OF LIGHT AND MEDIUM NUCLEI AT OVERBARRIER ENERGIES. Afonin, O. F.; Grinberg, A. P.; Lemberg, I. Kh.; Chugunov, I. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 219-32(Aug. 1967). (In Russian).

In order to investigate nuclear Coulomb excitation the coincidences were recorded of the γ-quanta and the ions elastically scattered at small angles. Thin targets were used. Sometimes the target was enriched with the isotope studied. The targets were bombarded with ^{12}C ions (36.8 MeV) and in some cases with ^{14}N ions (43.3 MeV). The values obtained of B(E2)↑ are given, and for the mixed transitions the values of B(M1)↑ as well. For the levels of ^{23}Na (2.08 MeV), ^{27}Al (3 MeV) and others (11 levels in all) the B(E2)↑ values were obtained in the Coulomb excitation experiments for the first time. For the levels of ^{27}Al (2.21 MeV), ^{50}Ti (1.58 MeV), ^{51}V (0.931 MeV) the B(E2)↑ values were determined with essentially more precision than the values available in the literature. (auth)

44627 TRIPLE $p\gamma\gamma$-CORRELATIONS STUDIES FROM THE REACTION $^{34}S(p,\gamma)^{35}Cl$. Kopanets, E. G.; Korda, Yu. S.; Koval, A. A.; Sukhotin, L. N.; Tsytko, S. P. Yadern. Fiz., 6: 233-9 (Aug. 1967). (In Russian).

The γ-spectrum from the resonance level E_{exc} = 8.385 MeV was studied in the reaction $^{34}S(p,\gamma)^{35}Cl$ at E_p = 2079 keV. Spin and parity of $5/2^+$ are assigned to the resonance level on the basis of the γ-ray angular distribution and triple $p\gamma\gamma$-correlations analysis. The most probable values of the mixture multipole coefficients are obtained for some γ transitions. The partial radiation widths of γ transitions are calculated to be 8.385; 6.6; and 1.76 MeV. The values of the matrix elements are found in Weisskopf units. (auth)

44628 CROSS SECTIONS OF THE REACTIONS (n,p) AND (n,α) AT NEUTRON ENERGY OF 14.8 MeV. Vinitskaya, G. P.; Levkovskii, V. N.; Sokolskii, V. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 6: 240-1(Aug. 1967). (In Russian).

Absolute cross sections were measured by the activation method for (n,p) and (n,α) reactions on isotopes of Br, Se, and As. (auth)

44629 (d,^{3}He) STUDIES ON ^{90}Zr, ^{89}Y, AND ^{88}Sr. Kavaloski, C. D.; Lilley, J. S.; Shreve, D. C.; Stein, Nelson (Univ. of Washington, Seattle). Phys. Rev., 161: 1107-15(Sept. 20, 1967). (RLO-1388-18).

The (d,^{3}He) reaction on ^{90}Zr, ^{89}Y, and ^{88}Sr was studied with 21-MeV deuterons from the University of Washington cyclotron. Angular distributions were obtained for transitions leading to the ground state and the 0.906-, 1.51-, and 1.75-MeV states of ^{89}Y, the ground state and the 1.84-, 3.21-, 3.48-, and 3.64-MeV states of ^{88}Sr, and to the ground state and the 0.403-, and 0.847-MeV states of ^{87}Rb over the laboratory angular interval 15 to 65°. The angular distributions were compared with predictions from a distorted-wave Born-approximation (DWBA) calculation, and spectroscopic factors were obtained. The l values of 1 and 3 were assigned to the transitions to the 3.48- and 3.64-MeV states of ^{88}Sr, respectively, for which the spins and parities were not previously known. On the basis of the DWBA analysis, large fractions of the $(2p_{\frac{1}{2}})^{-1}$ and $(1f_{\frac{5}{2}})^{-1}$ proton hole strengths are assigned to the first few excited states of ^{89}Y, ^{88}Sr, and ^{87}Rb, in qualitative agreement with simple shell-model predictions. (auth)

44630 FAST-NEUTRON BOMBARDMENT OF ^{64}Ni AND THE DECAY OF ^{61}Fe. Grench, H. A.; Coop, K. L.; Menlove, H. O. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Phys. Rev., 161: 1118-24(Sept. 20, 1967).

A 6.15 ± 0.06-min activity, which was assigned to the decay of ^{61}Fe, was produced as the result of bombardment of nickel enriched in ^{64}Ni with 15 to 19-MeV neutrons. The decay scheme was studied by β, γ, β-γ, and γ-γ counting techniques using plastic scintillators, NaI(Tl) crystals, and a Ge(Li) detector. Evidence was found for levels in ^{61}Co at 1.028 ± 0.005, 1.206 ± 0.005, 1.327 ± 0.005, 1.650 ± 0.015, and 1.995 ± 0.020 MeV. (auth)

44631 DECAY SCHEME, SPIN, AND MAGNETIC MOMENT OF 20-MIN ^{45}K. Garrett, G. J.; Jackson, A. D. Jr.; Ames, O. (Princeton Univ., N. J.). Phys. Rev., 161: 1152-6(Sept. 20, 1967). (PUC-937-253).

The 20-min ^{45}K isotope was studied using a lithium-drifted germanium detector and also by means of the atomic-beam magnetic-resonance method. The γ-ray studies revealed a new state in ^{45}Ca at 1883(3)-keV excitation; the now-measured spin of ^{45}K and other evidence indicate that this is a $1d_{\frac{3}{2}}$ hole state. The atomic-beam studies yielded $I = 3/2$ for ^{45}K and a value for the zero-field hyperfine structure separation $\Delta\nu$ = 204.5873(15) Mc/sec. From this the nuclear magnetic-dipole moment was calculated to be $|\mu_I|$ = 0.1734(4) nm (diamagnetically corrected). A calculation based on a model which describes ^{39}K through ^{43}K with considerable accuracy gives the result μ_I = +0.218 nm. Further calculation yields satisfactory values for the binding energies of ^{44}K through ^{47}K. (auth)

44632 STUDY OF ANALOG STATES BY THE (p,n) REACTION. Couchell, G. P.; Balamuth, D. P.; Horoshko, R. N.; Mitchell, G. E. (Columbia Univ., New York). Phys. Rev., 161: 1147-51(Sept. 20, 1967).

Isobaric-analog states were studied by measuring the total neutron yield from the (p,n) reaction on ^{65}Cu, ^{70}Zn, ^{74}Ge, ^{76}Ge, ^{75}As, and ^{80}Se. A large number of resonances was observed, and total widths extracted for approximately 50 of these resonances. Detailed comparison is made with the level schemes of nuclei formed by (d,p) reactions on the same targets. Coulomb displacement energies were extracted for all isotopes studied. (auth)

44633 SCATTERING OF 43-MeV ALPHA PARTICLES BY THE TITANIUM ISOTOPES. Yntema, J. L. (Argonne National Lab., Ill.); Satchler, G. R. Phys. Rev., 161: 1137-47(Sept. 20, 1967). (ORNL-P-3004).

The elastic and inelastic scattering of 43-MeV α particles on isotopically enriched Ti targets was measured. The results are analyzed by use of the distorted-wave theory and the collective model. The effect of the choice of different optical-model-potential parameters on the value of the deformation parameter β is investigated and found to be small for reasonable values of the potential parameters. In the three even-A isotopes, a number of 3^- and 4^+ levels have been identified. The excitation mechanisms of the first 2^+ and 4^+ state are compared with the results of coupled-equation calculations and with the predictions of the shell model and the vibrational model. (auth)

44634 ENERGY LEVELS OF ^{59}Fe FROM THE ^{58}Fe(d,p)^{59}Fe REACTION. Klema, E. D.; Lee, L. L. Jr.; Schiffer, J. P. (Argonne National Lab., Ill.). Phys. Rev., 161: 1134-6(Sept. 20, 1967).

The angular distributions of the protons from the ^{58}Fe(d,p)^{59}Fe reaction leading to eight states of ^{59}Fe were measured with 10-MeV deuterons at the Argonne tandem accelerator. Data were taken from 15° to 165°. Absolute cross sections were obtained by comparing the 7-MeV deuterons elastically scattered at 20° with the ground-state protons from the (d,p) reaction at E_d = 10 MeV. Values of the orbital-angular-momentum transfer and spectroscopic factors were obtained by comparing the measured cross sections at the forward peaks with those calculated by means of the distorted-wave Born approximation. Spins were assigned by use of the empirical J-dependence rules. The assignments E_{exc}(l,J,S) resulting from the present work are ground state (1,3/2,0.45); 0.287 MeV (1,1/2,0.22); 0.470 MeV (3,5/2,0.54); 0.728 MeV (1,3/2,0.20); 1.026 MeV ([3],[7/2],0.08); 1.214 MeV (1,1/2, 0.81); 1.572 MeV (4,9/2,1.07); and 1.749 MeV (2,5/2,[7/2],3.59/(2J + 1)). (auth)

44635 ENERGIES AND DECAY MODES OF ^{19}Ne STATES: ENERGIES OF FIRST EXCITED STATES OF ^{21}Ne, ^{21}Na, AND ^{22}Mg. Olness, J. W.; Poletti, A. R.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 161: 1131-3 (Sept. 20, 1967). (BNL-11355).

The energies and γ-decay modes of the lowest six energy levels of ^{19}Ne were investigated with the aid of Ge(Li) and NaI(Tl) γ-ray detectors. ^{19}Ne levels were populated by the ^{20}Ne(^{3}He,α)^{19}Ne action. Measurements were made of the energies of the first excited states of ^{21}Ne, ^{21}Na, and ^{22}Mg. These states were also formed by reactions initiated by ^{20}Ne + ^{3}He. (auth)

44636 NUCLEAR ENERGY LEVELS OF ^{37}K. Goosman, D. R.; Kavanagh, R. W. (California Inst. of Tech., Pasadena). Contract NONR-220(47). Phys. Rev., 161: 1156-80(Sept. 20, 1967).

Approximately 40 levels in ^{37}K were established via the reactions ^{40}Ca(p,α)^{37}K, ^{36}Ar(p,p)^{36}Ar, ^{36}Ar(p,γ)^{37}K, ^{36}Ar(p,p'γ)^{36}Ar, ^{36}Ar(d,n)^{37}K, and ^{36}Ar(^{3}He,d)^{37}K. Measurements of capture γ-ray energies with Ge(Li) counters made possible the determination of several level energies with precisions ranging from 1 to 5 keV. The analogs in ^{37}K of the first two excited levels in ^{37}Ar were found as a closely spaced doublet at 1368- and 1380-keV excitation energy. The half-life of the latter was measured electronically to be 9.6 ± 1.4 nsec. The energies (in keV), spins, and parities of the lowest eight levels are 0, 3/2$^+$; 1368 ± 3, (1/2$^+$); 1380 ± 2, 7/2$^-$; 2169 ± 5, (3/2$^-$); 2278 ± 9, (?); 2750 ± 1, 5/2$^+$; 3083 ± 4, (5/2$^-$); and 3311 ± 4, (3/2$^-$). Spin and parity assignments to other levels are also presented. Approximate values for the elastic and inelastic proton and γ-ray widths of several levels were determined. Evidence regarding the spins, parities, and widths of two candidates (at 5018 ± 3 and 5048 ± 3 keV) for the lowest T = 3/2 level is presented. The Q value for ^{36}Ar(p,γ) is 1857.0 ± 1.4 keV and the mass excess of ^{37}K on the ^{12}C = 0 scale is −24799.6 ± 2.7 keV. (auth)

44637 STUDIES OF γ RAYS FROM INELASTIC SCATTERING REACTION AND RADIATIVE CAPTURE OF PROTONS BY ^{26}Mg NUCLEI. Koval', A. A.; Kopanets, E. G.; Korda, Yu. S.; Sukhotin, L. N.; Tsytko, S. P. (Physical-Technical Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1213-20(July 1966). (In Russian).

The highly excited states of the ^{27}Al nucleus were investigated by means of the ^{26}Mg(p,p'γ)^{26}Mg and ^{26}Mg(p,γ)^{27}Al reactions, investigating the first one in the 2.3-to 3.0-MeV range. Thirty-five resonances were found in the study; they correspond to the excited states of ^{27}Al. In 31 of the resonances, the angular distribution of the E_γ = 1.82-MeV γ rays from the ^{26}Mg(p,p')^{26}Mg reaction were examined; the other 14 E_γ = 2.21-MeV resonances resulted from the second reaction. Analysis of the angular distribution made it possible to obtain the possible spin and parity value of the levels of the ^{27}Al nucleus. The target was prepared from electromagnetically separated ^{26}Mg on a tantalum support. The location of the resonances from the 2 reactions coincided within the precision of ±200 eV. The angular distribution function was derived from a Legendre polynomial series, determining the coefficients on a computer by the least squares method. (TTT)

44638 GAMMA-RAY SPECTRUM PRODUCED BY THERMAL NEUTRON CAPTURE IN ZINC ISOTOPES. Groshev, L. V.; Demidov, A. M.; Shadiev, N. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1136-41(July 1966). (In Russian).

The natural isotopic mixture of zinc consists of 5 isotopes; its thermal-neutron cross section is 1.10 ± 0.02 barn. The capture cross section of ^{66}Zn and ^{67}Zn is not known. These isotopes are responsible for about 60% of the total absorption cross section of the mixture. The γ spectrum of an isotopic mixture of zinc enriched in ^{68}Zn was examined by means of a 2% resolution magnetic Compton spectrometer on the Minsk reactor. From the comparison of the results with those obtained with the natural isotopic mixture it was concluded that 93% of the intensity of the 7857-keV line belongs to ^{65}Zn. The transition to the 120-keV level in ^{65}Zn is very strong; on the other hand the transition to the 60-keV level, if it exists at all, is negligible. The even-even ^{68}Zn isotope has the highest neutron binding energy of all zinc isotopes, and therefore its γ ray spectrum from the (n,γ) reaction possesses levels within a broad excitation energy range. The isotope formed after the neutron capture may exist in 2- or 3-states. No transition to the 1.66-MeV level was observed in ^{68}Zn; the M1 transition to the 2.68-MeV 3-level was not observed either. (TTT)

44639 DEFORMED STATES IN ^{43}Sc: THE LIFETIME OF THE 472 keV LEVEL. Critchley, T. A.; Phillips, W. R. (Univ. of Manchester, Eng.). Phys. Lett., 25B: 328-30(Sept. 18, 1967).

The mean life of the 472-keV excited state of ^{43}Sc was measured by a Doppler shift recoil method to be 0.52 ± 0.15 ns. The E2 strength of the ground-state transition is enhanced by a factor of five over the single-particle estimate. (auth)

44640 HOW GOOD IS THE SHELL CLOSURE AT N = 28? Glover, R. N.; Douglas, A. C. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Phys. Lett., 25B: 333-5 (Sept. 18, 1967).

Absolute cross sections are measured for the ^{46}Ca(t,p)^{48}Ca and ^{48}Ca(t,p)^{50}Ca reactions. Calculations suggest that the change in cross section as the $f_{\frac{7}{2}}$ neutron shell closes at ^{48}Ca is consistent with 20 to 30% p admixture in the ^{48}Ca ground state. (auth)

44641 QUADRUPOLE MOMENT AND EFFECTIVE E2 TRANSITION MOMENTS IN ^{51}V. Talmi, I. (Princeton Univ., N. J.). Phys. Lett., 25B: 313-16(Sept. 18, 1967).

Recently measured E2 rates for Coulomb excitation from the ground state of ^{51}V to excited states are consistent with the use of effective single particle E2 operators and $f^3_{\frac{7}{2}}$ wave functions. From these operators the quadrupole moment of ^{51}V is calculated and found to be in very good agreement with the new experimental (negative) value. The enhancement of the single proton E2 operator is equivalent to an effective charge e_{eff} = 1.61e. (auth)

44642 THE ANGULAR DISTRIBUTION OF FAST PHOTONEUTRONS FOR NUCLIDES WITH N ABOUT 56. Hussain, S. M.; McNeill, K. G. (Univ. of Toronto, Ont.). Can. J. Phys., 45: 2851-7(Sept. 1967).

Measurements were made of the angular distributions of fast (E > 5 MeV) photoneutrons from eight elements in the region Z = 28 to Z = 50, and from lead, using threshold detectors. It is found that there is evidence for peaking of the anisotropy of these photoneutrons at the closing of the N = 56 subshell. (auth)

44643 CHARGE EXCHANGE EFFECTS IN ^{80}Se(d,p)^{81}Se. Coker, W. R.; Moore, C. F. (Univ. of Texas, Austin). Phys. Lett., 25B: 271-3(Sept. 4, 1967). (ORO-2972-32).

Excitation curves were measured for ^{80}Se(d,p) leading to six states in ^{81}Se. Curves were measured at 160° at deutron energies between 5.6 and 8.3 MeV. Small anomalies in these excitation curves were seen at the threshold of the (d,n) reaction to the corresponding analog states in ^{81}Br. (auth)

44644 THE J → J RULE FOR M1 TRANSITIONS IN ^{38}Ar. Engelbertink, G. A. P.; Endt, P. M. (Rijksuniversiteit, Utrecht). Phys. Lett., 25B: 263-5(Sept. 4, 1967).

The γ decay of resonances in the ^{37}Cl(p,γ)^{38}Ar reaction in the E_p = 1 to 2-MeV region was investigated with a Ge(Li) counter. Mean lives of 11 bound states are found from γ-ray Doppler shift measurements. The J^π values of resonances and three bound states are obtained from γ-ray angular-distribution and polarization measurements. The E_p = 1732 keV, $J^\pi = 4^-$, resonance can be regarded as the analog of ^{38}Cl(3). The enhancement of J → J M1 transitions, formerly observed for $5^- \rightarrow 5^-$, was also observed for $3^- \rightarrow 3^-$ and $4^- \rightarrow 4^-$ transitions. (auth)

44645 A STUDY OF FISSION-NEUTRON SPECTRA WITH HIGH-ENERGY ACTIVATION DETECTORS. PART I. DETECTOR DEVELOPMENT AND EXCITATION MEASUREMENTS. Grundl, James A. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-Eng-36. Nucl. Sci. Eng., 30: 39-53(Oct. 1967). (LA-DC-8101).

Eight activation detectors, ^{235}U(n,f), Np(n,f), ^{238}U(n,f), P(n,p), Al(n,p), ^{56}Fe(n,p), Al(n,α), and ^{63}Cu(n,2n) are placed on a firm experimental foundation to prepare for the investigation of fission-neutron spectra in Part II. Gross beta-gamma counting with methane-flow counters is employed to achieve the exceptional stability of detector response required for spectrum determina-

tions. Calibration and specification of detector excitations are based on relative cross-section measurements performed at the Los Alamos Van de Graaff. The latter were tailored to supplement existing cross-section information and to aid in its evaluation. Deduced detector excitations are specified in fifty energy groups with uncertainties assigned in a separate seven-group excitation structure appropriate for the investigation of distributed neutron spectra. (auth)

44646 ^{99}Mo HALF-LIFE DETERMINATION. Baldwin, M. N. (Babcock and Wilcox Co., Lynchburg, Va.). Nucl. Sci. Eng., 30: 144-54(Oct. 1967).

The half-life of ^{99}Mo was measured by irradiating MoO_3 with thermal neutrons and counting the β and γ activities induced. The γ spectra showed no peaks other than those belonging to ^{99}Mo and ^{99m}Tc. The decay of one sample was followed with two end-window gas-flow proportional counters for 8 half-lives. An unweighted average value of 65.98 ± 0.10 was obtained for the half-life. (D.C.W.)

44647 THE BETA DECAYS OF ^{22}Mg, ^{30}S, AND ^{34}Ar. Barker, P. H.; Drysdale, N.; Phillips, W. R. (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 91: 587-99(July 1967).

The beta decays of ^{22}Mg, ^{30}S and ^{34}Ar have been investigated with the following results: For ^{22}Mg, $\tau_{\frac{1}{2}}$ = 3.99 ± 0.12 sec. The decay proceeds in 59 ± 2% of the cases to the 656-keV 0^+ level in ^{22}Na, and in 41 ± 2% of the cases to the 583-keV 1^+ level in ^{22}Na. The end point of the superallowed beta particles was determined, using the ^{20}Ne(^{3}He,n)^{22}Mg reaction, to be 3.146 ± 0.035 MeV. For ^{30}S, $\tau_{\frac{1}{2}}$ = 1.18 ± 0.04 sec. The decay proceeds in 20 ± 1% of the cases to the ground state of ^{30}P, and in 80 ± 1% of the cases to the 676-keV 0^+ level in ^{30}P. Less than 1.6% of the decays proceed to the 707-keV 1^+ level in ^{30}P. For ^{34}Ar, $\tau_{\frac{1}{2}}$ = 0.85 ± 0.10 sec. There is no decay that proceeds with more than 20% of the main decay, which is to the ground state of ^{34}Cl. Log-ft values are deduced and discussed. (auth) (UK)

44648 INVESTIGATION OF ^{41}K BY PROTON-INDUCED REACTIONS ON ^{40}Ar. Slivinsky, V. W. (Pennsylvania State Univ., University Park); Winter, R. F. Nucl. Phys., A102: 295-304(1967).

Yield curves for ^{40}Ar(p,p_0), (p,p_1), (p,p_2), (p,p_3), and (p,α_0) reactions on ^{40}Ar were obtained from 3.5- to 6.0-MeV incident proton energy. Strong excitations suggesting the formation of analog states were found, especially in the (p,p_3) reaction. Spins for some of the ^{41}K states were assigned from angular-distribution analyses. Ericson's fluctuation theory was used to analyze the alpha data and yielded 3.9 ± 0.9 keV for the mean width of states of ^{41}K in the 12.3- to 13.5-MeV excitation energy interval. (auth)

44649 ELASTIC AND INELASTIC SCATTERING OF 29 MeV ^{3}He BY ^{24}Mg. Griffiths, R. J. (Univ. of Colorado, Boulder). Contract AT(11-1)-535. Nucl. Phys., A102: 329-36(1967). (UCOL-535-564).

Absolute differential cross sections of 29-MeV ^{3}He nuclei elastically and inelastically scattered from ^{24}Mg are presented and compared with optical-model and DWBA calculations. (auth)

44650 ^{27}Al(p,γ)^{28}Si RESONANCE WIDTHS WITH STUDY OF TEMPERATURE AND CONTAMINANT EFFECTS. Donhowe, J. M.; Ferry, J. A.; Mourad, W. G.; Herb, R. G. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Nucl. Phys., A102: 383-405(1967). (COO-7-0416).

A description is given of methods used to determine nuclear reaction widths from reaction yield curves. Limitations on the precision of measurement due to the Doppler width, contaminant effects effects, beam energy spread, and voltage instability are analyzed. Experimental equipment was developed to reduce each of these spreading factors. Nuclear resonance half-widths were determined at the resonances near 992, 1262, 1317, 1328, 1364, and 1388 keV. The width of the resonance near 1388 keV, Γ = 550 ± 110 eV, is at variance with the published estimate of 190 ± 80 eV. The confusing effect of contaminants was reduced by attainment of a target chamber pressure during evaporation of the target of 3×10^{-9} mm Hg in the best case, and 5×10^{-11} mm Hg during proton bombardment. Yield curves taken from cold targets could not be fitted to calculated yield curves over the ^{27}Al(p,γ)^{28}Si resonance near 774 keV (Γ = 14 ± 3 eV) if the Doppler width, $\Delta = 2(R\Gamma)^{\frac{1}{2}}$, was calculated in the Debye approximation. The observed variation with temperature of the Doppler width exceeds that predicted by Debye or Einstein theories for specific heats in solids. Favorable comparison of calculated and experimental yield curves was made if the classical approximation to the Doppler width was assumed: namely, $\Delta = 2(RkT)^{\frac{1}{2}}$. For Al at T = 80°K this represents a difference in estimated values of the Doppler width of over 40%. (auth)

44651 PRECISE MEASUREMENT OF RELATIVE ENERGY POSITIONS AND WIDTHS OF SOME (p,γ) RESONANCES IN ALUMINIUM AND SODIUM. Mourad, W. G.; Nielsen, K. E.; Petrilak, M. Jr. (Univ. of Wisconsin, Madison). Contract AT(11-1)-Gen-7. Nucl. Phys., A102: 406-32(1967). (COO-7-0417).

The energy positions or ratios of the ^{27}Al(p,γ)^{28}Si resonances at 774, 1317, and 1364 keV, were determined to 33, 50, and 50 parts per million (ppM) respectively, relative to the resonance at 992 keV taken as a standard with an adopted absolute value of 991.90 ± 0.04 keV. This accuracy was made possible by use of a 90° cylindrical electrostatic analyzer of 1 m radius in which: the plates were aligned parallel such that the gap between them was kept constant over an 8 mm vertical region to about one wavelength of sodium light for 90% of the length of the analyzer; and the voltage applied to the plates could be held constant to about 30 ppM. Relative to the same standard in aluminium, the energy ratios and the widths of ten ^{23}Na(p,γ)^{24}Mg resonances at 987, 1009, 1011, 1020, 1174, 1283, 1318, 1396, 1417, and 1457 keV were determined. Some evidence for a fine structure in the resonances at 1283 keV and 1457 keV exists but is not conclusive. In these measurements, the discrete nature of energy losses of the protons in the target was taken into account, the relativistic corrections were applied, and all the data were taken with an energy resolution E/ΔE of about 10500. Some of these results are at variance with previously published work. The γ-ray yield of the narrow sodium resonance at 1417 keV was studied both at room temperature and in the neighborhood of 80°K. Its energy ratio relative to the 992 keV resonance in aluminium was determined to 50 ppM. (auth)

44652 SPECTROSCOPIC STUDY OF $^{47\ 49\ 51}$V WITH THE (^{3}He,d) REACTION AT 10 MeV. St.-Pierre, Claude; Maheshwari, P. N.; Doutriaux, D.; Lamarche, L. (Univ. Laval, Quebec). Nucl. Phys., A102: 433-42(1967).

The (^{3}He,d) reaction on ^{46,48,50}Ti was investigated with a 10 MeV beam of doubly ionized ^{3}He. The deuterons were analyzed with a semiconductor E-ΔE particle identification system. Levels of ^{47,49,51}V were observed up to excitation energies of 2.22, 4.22, and 4.25 MeV, respectively, with an energy resolution between 80 and 120 keV. The angular distributions were measured at lab angles between 15° and 120° and compared with the predictions of a DWBA calculation using the TSALLY code. The angular momentum transfer was identified as l = 3 for ^{49,51}V ground states and ^{47}V 0.15 MeV state, and l = 1 for all the observed excited states of ^{49,51}V and ^{47}V ground, 2.08 and 2.22 MeV states. The 0.26 MeV $\frac{3}{2}^+$ hole state and 1.66 MeV $\frac{1}{2}^+$ hole state of ^{47}V were also observed. Spin and parity could be assigned to most levels, and the corresponding spectroscopic factors were determined. (auth)

44653 EVEN-PARITY STATES OF ^{41}Ca BY THE ^{39}K(^{3}He,p)^{41}Ca REACTION. Belote, T. A.; Dao, F. T.; Dorenbusch, W. E.; Kuperus, J.; Rapaport, J.; Smith, S. M. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A102: 462-72(1967). (MIT-2098-331).

The ^{39}K(^{3}He,p)^{41}Ca reaction was investigated at 13 MeV bombarding energy. Angular-distribution data for 20 levels were obtained and were analyzed using the DWBA. The results show the two-particle, one-hole character of many of the even-parity states of ^{41}Ca and are compared with the calculated even-parity level scheme. A discussion of the results in terms of possible intermediate structure is given. (auth)

44654 ROTATIONAL MODEL REPRESENTATION OF LOW-LYING EXCITED STATES IN ^{23}Na. El-Batanoni, F.; Kresnin, A. A. (Atomic Energy Establishment, Cairo). Nucl. Phys., A102: 473-6(1967).

Low-lying excited states in ^{23}Na are described strictly in the framework of the strong coupling rotational model with the account of the Coriolis interaction using a minimum number of free parameters. The calculated level scheme and ground state properties of ^{23}Na are in good agreement with the available experimental data. (auth)

44655 STUDY OF THE ^{31}P(n,γ)^{32}P REACTION. Lyckiama, H.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 45: 3039-54(Sept. 1967).

A total of 64 transitions was observed with an average precision of 2 keV in studying the gamma radiation from the ^{31}P(n,γ)^{32}P reaction using a Ge(Li) spectrometer. The neutron separation energy was measured to be 7,936 ± 1 keV. Comparison with (d,p) results indicates only a weak correlation between (n,γ) and (d,p) reduced widths. The reduced radiation widths follow a χ^2 distribution of ~2 degrees of freedom. (auth)

44656 MEAN REACTOR CROSS SECTIONS FOR (n,p) REACTIONS ON TITANIUM. Deschuyter, M.; Hoste, J. (Ghent Univ.). Radiochim. Acta, 7: 198-201(Aug. 1967).

The mean reactor cross sections for the reactions ^{46}Ti(n,p)^{46}Sc, ^{47}Ti(n,p)^{47}Sc, and ^{48}Ti(n,p)^{48}Sc were experimentally determined by irradiation in a reactor. The interference of the ^{45}Sc-impurity,

which produces the same isotope through a(n,γ) reaction, was calculated by irradiating with and without a Cd cover. The measured mean fission neutron cross sections are 8.6 ± 1.4; 18.2 ± 2.6, and 0.11 ± 0.01, whereas the predicted values, according to Roy and Hawton are 9.0; 14.0, and 1.0 mb, respectively. (auth)

44657 TABLE OF ISOTOPES. SIXTH EDITION. Lederer, C. Michael; Hollander, Jack M.; Perlman, Isadore. New York, John Wiley and Sons, Inc., 1967. 606p. $7.95.

A table is given which displays data for all radioactive and stable nuclei arranged according to atomic number with increasing mass number for each element. The criterion for the selection of data on each radioactive isotope was that of identifying it in terms of its rate and mode of decay, principal radiations, and how it is prepared. Detailed information on nuclear energy levels and transitions between these levels is given. The general policy adopted for these entries was that they be based on direct experimental information. Spin and parity assignments based wholly, or in large part, on the expectations from nuclear models were avoided. Unobserved transitions that should be present were omitted, with few exceptions. A complete bibliography of the sources of information is included. (S.F.L.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 43813, 44280, 44533, 44585, 44594, 44601, 44616, 44620, 44629, 44642, 44645, 44657, 44733, and 44799.

44658 (CEA-R-2830) TABLE DES ISOMERES. (Table of Isomers). Dupont-Gautier, Pierrette; Chantelot, Simone; Moisson, Nicole (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 485p. (In French). Dep.

A compilation of conversion coefficients, decay schemes, and formation modes (decays and reactions) for metastable isomers with lifetimes of the order of 0.1×10^{-6} sec or greater is presented. References are included, and the cross sections of reactions leading to the formation of the isomers are included where they are available. The isomers are listed in order of increasing lifetime. (D.C.W.)

44659 (CEA-R-3091) CONTRIBUTION AU MODELE OPTIQUE PAR LA MESURE DE SECTIONS DE REACTION. (Contribution to the Optical Model Study by Measurement of Reaction Cross Sections). Delaunay, Jeannine (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1966. 50p. (In French). Dep.

Thesis. Submitted to Univ., Paris.

Excitation functions of the reaction cross section δR for protons were obtained between 5 and 11 MeV for ^{141}Pr and ^{150}Nd by radioactive techniques and between 9 and 12 MeV for Cu and Ni by the transmission method. Results were compared to predictions of the optical model. Calculations were made to see in what part δR is able to reduce the ambiguities of the optical model. (auth)

44660 (CONF-660925, pp 789-818) PANEL DISCUSSION ON NEUTRON AND FISSION PHYSICS.

Topics discussed are: fission induced by thermal neutrons; fission at all energies except thermal; total cross sections measured with small samples, and general considerations of slow neutron spectrometers; measurements using polarized neutron beams and polarized targets; experiments to study the neutron–neutron interaction; and fast neutron spectrometers. (S.F.L.)

44661 (COO-7-0424) MAGNETIC MOMENTS OF THE FIRST EXCITED 2^+ STATES IN EVEN Hg ISOTOPES. Kalish, R.; Grodzins, L.; Murnick, D. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science); Borchers, R. R.; Herskind, B.; Bronson, J. D. (Wisconsin Univ., Madison). Aug. 29, 1967. Contract AT(11-1)-Gen-7. 14p. (CONF-670812-10). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

The Larmor precession angles for the Coulomb-excited first 2^+ states of ^{198}Hg, ^{200}Hg, ^{202}Hg, and ^{204}Hg, implanted into a polarized iron lattice, were determined by IMPACT. The effective magnetic field on ^{198}Hg is a factor of two smaller than the effective field observed using radioactive sources. The present results, normalized to the known g value of the 2^+ state in ^{198}Hg, g = 0.55 ± 0.11, measured in an external magnetic field, yield g values for the 2^+ states of ^{200}Hg, ^{202}Hg, and ^{204}Hg of 0.73 ± 0.27, 0.77 ± 0.23 and 0.29 ± 0.15 respectively. The g values for the 2^+ states of ^{198}Hg and ^{200}Hg are greater than Z/A, in accord with the predictions of Kumar and of Covello. A sharp decline in g values of 2^+ states, between ^{200}Hg and ^{202}Hg, predicted by Kumar, is not observed. A large decrease in g values of 2^+ states appears to occur between ^{202}Hg and ^{204}Hg. (auth)

44662 (COO-1663-2) DETERMINATION OF THE PARAMETERS OF NUCLEAR STATES. Annual Report. Mandeville, C. E. (Kansas State Univ., Manhattan). Sept. 1, 1967. Contract AT(11-1)-1663. 35p. Dep. CFSTI.

The energies and relative intensities of the gamma rays of ^{193}Os ($T_{\frac{1}{2}}$ = 32 hr) were measured using a Ge(Li) detector. Gamma-gamma coincidences and beta-gamma coincidences were studied to obtain energies of nuclear states in ^{193}Ir. In all, twenty-four detected gamma transitions were ordered between eleven nuclear energy states. The energies of these transitions are 73, 98, 107, 139, 180, 219, 252, 281, 289, 299, 322, 362, 379, 388, 420, 438, 461, 486, 512, 533, 559, 574, 713, and 874 keV, establishing excited energy states at 73, 139, 180, 362, 438, 461, 559, 680, 713, and 874 keV in the nucleus of ^{193}Ir. Gamma rays corresponding to transition energies of 618, 780, and 830 keV were also observed, but these transitions could not be suitably incorporated into the disintegration scheme. ^{191}Os was produced by slow neutron capture in ^{190}Os. A gamma ray at 187 keV was emitted from the irradiated target material, but its intensity was found to decay with a half-life different from that of ^{191}Os. Isotopically concentrated ^{154}Sm was irradiated in a research reactor to produce ^{155}Sm which decays by beta emission to ^{155}Eu. Twenty-nine gamma rays, observed in Ge(Li) detectors, were ordered in a nuclear structure diagram which contains levels having the following excitation energies in keV, spins, and parities: $0(\frac{5}{2}^+)$, $79(\frac{7}{2}^+)$, $105(\frac{5}{2}^-)$, $168(\frac{1}{2}^-)$, $246(\frac{3}{2}^+)$, $307(\frac{5}{2}^+)$, $614(\frac{7}{2}^-)$, $768(\frac{1}{2}^+)$, $782(\frac{3}{2}^+)$, $876(\frac{5}{2}^+)$, $1102(\frac{3}{2}^-)$, $1264(\frac{1}{2}^-, \frac{1}{2}^+, \frac{3}{2}^+)$, and $1302(\frac{1}{2}^-, \frac{1}{2}^+, \frac{3}{2}^+)$. These nuclear states of ^{155}Eu were assigned Nilsson numbers, or rotational properties. (auth)

44663 (FOA-4-4316-28) FISSION PRODUCT GENETICS. Jakobsson, S. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Sept. 1967. 20p. Dep. CFSTI. SWED.

An extensive compilation of half-lives and genetic relations of fission products is presented for the literature up to early 1966. All data are presented in decay chains to permit rapid reading. (auth) (SWEDEN)

44664 (INP-546/PL) EXCITED STATES OF ^{155}Gd NUCLEUS. Kormicki, Jan; Niewodniczanski, Henryk; Stachura, Zbigniew; Zuber, Kazimierz; Budziak, Alicja (Institute of Nuclear Physics, Krakow (Poland)). May 1967. 41p. Dep.

The internal conversion electron spectrum of the decay of ^{155}Tb into ^{155}Gd in the energy range from 8 to 600 keV was measured with the aid of a semicircular beta-ray spectrograph. The activity was produced in spallation of Ta nuclei with 660-MeV protons. The energies and relative intensities of conversion lines were measured, and for some transitions their multipolarities and mixing ratios were also determined. The experimental data obtained are presented in the decay scheme of ^{155}Tb. The decay scheme is discussed in terms of the Nilsson model, taking into account the Coriolis coupling and the interaction between states differing in oscillator quantum number by ΔN = 2. From the obtained experimental data the matrix element of the interaction $|\langle[402]\frac{3}{2}^+|\mathcal{H}_0|[651]\frac{3}{2}^+\rangle|$ and the Coriolis-coupling parameters of the interaction between states $[651]\frac{3}{2}^+$ and $[642]\frac{5}{2}^+$, and between states $[660]\frac{1}{2}^+$ and $[651]\frac{3}{2}^+$ were estimated and the values obtained were compared with the theoretical predictions. (auth)

44665 (INP-547/PL) TERNARY FISSION OF ^{238}U AND ^{232}Th NUCLEI INDUCED BY 2.9 MeV NEUTRONS. Benisz, Jerzy (Institute of Nuclear Physics, Krakow (Poland)). June 1967. 20p. Dep.

The ternary fission mechanism of ^{238}U and ^{232}Th induced by 2.9-MeV neutrons was investigated. Two modes of ternary fission of ^{239}U and ^{233}Th were determined. The average total kinetic energy of fragments was found to be 182 MeV for ternary fission of ^{239}U and 165 MeV for ternary fission of ^{233}Th. The frequency of occurrence of ternary fission relative to binary fission was found to be 9×10^{-4} for fission of ^{238}U induced by 2.9-MeV neutrons and 3×10^{-3} for fission of ^{232}Th induced by 2.9-MeV neutrons. (auth)

44666 (INR-795/I/PL) EXCITATION CURVE OF THE REACTION ^{181}Ta(n,2n)^{180m}Ta. Brzosko, J.; Fryszczyn, B.; Gierlik, E.; Saganek, A.; Soltan, A. Jr.; Wilhelmi, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 15p. Dep.

The activation method was applied to measure the cross sections producing the isomeric state of ^{180}Ta(8.12 hr) formed in the reaction (n,2n) in the range of neutron energy from 12.2 to 17.9 MeV. The obtained experimental values were compared with those theoretically predicted based on the statistical model.

The comparison showed a discrepancy between the experiment and the predictions of the statistical theory with Fermi gas level density. (auth)

44667 (KFK-562) KOINZIDENZEXPERIMENTE BEI NEUTRONENEINFANGREAKTIONEN. (Coincidence Experiments for Neutron Capture Reactions). Michaelis, W.; Fanger, U.; Lange, D.; Markus, G.; Schmidt, H.; Weitkamp, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Mar. 1967. 10p. (In German). Dep.

A summary is given of the coincidence studies made at the Karlsruhe SR2 reactor. The multiparameter experiments and the coincidence methods used for the precision measurement of individual spectra are described. Some typical results are reported. (J.S.R.)

44668 (N-67-21764) COMPARISON BETWEEN THE TWO-QUASIPARTICLE AND FOUR-QUASIPARTICLE TAMM-DANCOFF APPROXIMATIONS FOR EVEN PARITY STATES OF EVEN TIN ISOTOPES CALCULATED WITH FINITE RANGE FORCES. Ottaviani, P. L.; Savoia, M.; Sawicki, J. (International Centre for Theoretical Physics, Trieste (Italy)). Feb. 1967. 26p. (IC-67/5). CFSTI.

The second quasiparticle Tamm-Dancoff theory is applied to the study of even-parity states of even tin isotopes and is compared with the quasiparticle Tamm-Dancoff theory. Numerical computations were performed with several Gaussian and P_2 residual interaction potentials. In contrast to previous results with a delta force, here reasonable finite-range forces permit accounting for the 0^+ states as well as for the 2^+ and 4^+ states. Four-quasiparticle correlations are included in the ground state. The spurious states of the nucleon number operator are projected out. While the first excited 2^+ and 4^+ states are generally of almost pure two-quasiparticle character, the first excited 0^+ state is quite of the two-quasiparticle, four-quasiparticle mixed type. The E2 transition probabilities and Q_2, the quadrupole moments of the 2^+ states, are calculated and discussed. (auth) (STAR)

44669 (NAA-SR-12499) MEASUREMENT OF THE EFFECTIVE RESONANCE INTEGRAL, THERMAL ATTENUATION FACTOR, AND DOPPLER EFFECT IN GOLD OVER A WIDE RANGE IN SURFACE/MASS RATIO AND TEMPERATURE. Beller, L. S.; Farrar IV, H. (Atomics International, Canoga Park, Calif.). Aug. 15, 1967. Contract AT(04-3)-701. 62p. Dep. CFSTI.

Measurements of the effective resonance integral, thermal and epithermal self-shielding factors, and Doppler coefficients α and β in the isotope ^{197}Au are reported. The measurements cover a range of more than four decades in surface/mass ratio (S/M), and 500°C in temperature in four steps. The measurements were made by activation in a nominally 1/E neutron energy spectrum. The objective was to provide correlated experimental data-the accuracies and limitations of which are well understood-for use in examining the effect of theoretical approximations in the calculation by analytical methods of both resonance integrals and Doppler effects. For this purpose, it was important that the data cover as wide a range as possible of important parameters. The measurements disclosed comparatively large discrepancies with the TRIX-I theory, due to certain approximations that originally had been considered to have only minor effect. As a result, calculational methods have been improved, and the new methods (TRIX-II code) are in excellent agreement with the measurements. The experimental methods are described in detail. These methods resulted in exceptionally good reproducibility of measurement. The measurements of the Doppler effects are not in as good agreement with TRIX-I calculations, but the causes appear to lie in the calculation and not the experiment. The present measurements are believed to constitute the first in which the Doppler effect as a function of temperature extends over a large span in S/M, and into the thin-sample region dominated by a single resonance. The approximate $(T)^{-\frac{1}{2}}$ temperature dependence found by others for small S/M in other isotopes was confirmed for the conditions of these measurements. (auth)

44670 (UCRL-17723) COMPILATION OF EXPERIMENTAL E_α VALUES IN THE REGION ABOVE Z = 81 AND BELOW N = 128. Valli, Kalevi (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 29p. (CONF-670818-3). Dep. CFSTI.

From 3rd International Conference on Atomic Masses, Winnipeg, Canada.

Alpha-particle energies, alpha-decay energies, alpha branches, and half-lives are presented for Ac, Bi, Fr, Ra, Rn, and Th isotopes with N < 128 and Z > 81. At isotopes lighter than ^{206}At, Po isotopes lighter than ^{204}Po, and some recent results on ^{208}At and ^{209}At are also listed. (D.C.W.)

44671 (UCRL-50243(Vol.1)) THE FISSION PRODUCT DECAY CHAINS (^{239}Pu WITH FISSION SPECTRUM NEUTRONS). VOLUME I. ATOMIC FRACTION OF THE TOTAL CHAIN YIELD VS. TIME. Discussion; Decay Chain Diagrams. Fleming, Edward H. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 31, 1967. Contract W-7405-eng-48. 435p. Dep. CFSTI.

Three parameters for each radionuclide in each fission product mass chain were computed and plotted vs time from 0.6 seconds to about two years. The parameters are: the (atom) fraction of the total chain yield, i.e., the ratio of the number of atoms of a given nuclide in a mass chain to the sum of the atoms of all nuclides in the mass chain; the number of kilocuries per kiloton of fission; and the number of roentgens per hour per kiloton per square mile. Each decay chain diagram is presented together with the following values for each nuclide in the chain—the half-life, the independent yield, the photon dose-rate multiplier, the zero time atom fraction, the kilocuries per kiloton per fraction, and the roentgens per hour per kiloton per square mile per fraction. Total fission product sums of KCi/kt and of $R \cdot Mi^2/h \cdot kt$, each vs time from 0.6 second to about two years, were computed and plotted. (auth)

44672 (UCRL-50243(Vol.2)) THE FISSION PRODUCT DECAY CHAINS (^{239}Pu WITH FISSION SPECTRUM NEUTRONS). VOLUME II. KILOCURIES PER KILOTON VS. TIME. Fleming, Edward H. Jr. (California Univ., Livermore. Lawrence Radiation Lab.). Mar. 31, 1967. Contract W-7405-eng-48. 345p. Dep. CFSTI.

Plots of total kCi/kton vs time are presented for the individual mass chains and for all the nuclides involved. (D.C.W.)

44673 DECAY SCHEME OF ^{143}Sm. Belyanin, Yu. I.; Biryukov, E. I.; Shimanskaya, N. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1130-5(July 1966). (In Russian).

Although the relatively high decay energy and the presence of a γ spectrum in the similar isotopes of ^{139}Ce and ^{141}Nd strongly indicate that the radioactive emission spectrum of ^{143}Sm must contain many γ lines, the γ spectrum of this isotope has not been examined before. Therefore, together with the limiting energy of the β^+ spectrum of ^{143}Sm, its half-life, and the K/β^+ ratio, the γ spectrum of the isotope was also investigated. The sources used were prepared by means of the ^{144}Sm(n,2n)^{143}Sm reaction, exposing samarium oxide containing up to 54.8% ^{144}Sm to a 14-MeV neutron flux. The half-life of ^{143}Sm was found to be 8.9 ± 0.2 min; the limiting energy of the β^+ spectrum was E_{lim} = 2.47 ± 0.03 MeV. The K/β^+ ratio of 0.98 ± 0.09 agreed with the theoretical value indicating a $\frac{5}{2}$ spin. Study of the γ spectrum by means of a scintillation γ spectrometer revealed the presence of 750-, 1070-, 1200-, 1460-, and 1740-keV lines near the annihilation radiation. The decay results in the formation of ^{143}Pm which has the magic number of N = 82 and therefore has a spherical equilibrium shape. (TTT)

44674 DECAY SCHEME OF ^{125}Sb. Mazets, E. P.; Sergeenkov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1185-92(July 1966). (In Russian).

In order to resolve inconsistencies in the previously reported decay schemes of ^{125}Sb, the β spectrum and internal conversion electron spectrum of this isotope were studied by means of a prismatic β spectrometer. The ^{125}Sb was prepared by the irradiation of ^{124}Sb in a reactor, leaching out the antimony from the irradiated tin by extraction without carrier with di-n-butyl ether. It was found that the K and L lines of the internal conversion electrons correspond to 23 γ transitions. Most of these transitions were not directly observed but were determined by $\gamma\gamma$ coincidences. In the high-energy range, the conversion lines at the L subshells could not be resolved, but it was found to be possible to separate them by graphic analysis. The 176.29- and 427.95-keV lines exhibited a compound M1 + E2 character. On the basis of the new experimental data and previous literature reports, a decay scheme was derived for ^{125}Sb. The structure of the ^{125}Te levels excited in the β decay of ^{125}Sb was also established. (TTT)

44675 DECAY SCHEME OF ^{146}Gd. Avotina, M. P.; Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1204-9(July 1966). (In Russian).

Even though the ^{146}Gd nucleus was identified in 1958, the characteristics of the levels of ^{146}Eu have not yet been determined. This odd-odd nucleus is of great interest because of its relatively simple "particle-hole" configuration. Therefore, the internal conversion electron spectrum of ^{146}Gd was studied by means of a $2\pi\sqrt{2}$-type β spectrometer, using a preparation of the gadolinium fraction containing the $^{146-153}$Gd isotopes and their decay products; the fraction itself was prepared by the chemical and chromatographic separation of the isotopes formed by the bombardment of tantalum and erbium targets with 660-MeV protons in a synchro-

cyclotron. The proton resonance method used made it possible to determine more precisely than was possible before the γ transition energies. The 114.75-, 115.57-, and 154.70-keV transitions were found to possess M1 multipolarity, with only <1% E2. On the basis of the data, the decay scheme of ^{146}Gd → ^{146}Eu was identified finding that the 269.5-keV transition must have an E2 multipolarity. In view of the shortcomings of the presently accepted theory, the ^{146}Eu → ^{146}Sm decay was also examined, determining the number of K conversion electrons of the 747.4-keV γ transition per 100 decays of the daughter ^{146}Eu. The findings agreed with data reported in previous papers. (TTT)

44676 K AUGER ELECTRON SPECTRUM OF LUTETIUM. Gizon, J.; Boutet, J. (Faculte des Sciences, Grenoble, France). Nucl. Phys., A103: 9-16(1967). (In French).

The K Auger spectrum of Lu (Z = 71) in the electron-capture decay of ^{175}Hf was studied by means of an iron-free, 50-cm-radius, $\pi\sqrt{2}$ β-ray spectrometer. The energies and relative intensities of the 9 KLL Auger lines and satellites were measured. The KLX Auger spectrum was also recorded. The energies and intensities of 14 lines and groups are given. The ratio KLX/KLL is equal to 0.51 ± 0.04. These results are compared with theoretical values. (auth)

44677 TWO-PARTICLE–TWO-HOLE CONFIGURATIONS IN THE DIPOLE RESONANCES OF ^{90}Zr. Obst, E.; Rauch, F.; Wahsweiler, H. G. (Univ., Frankfurt am Main). Nucl. Phys., A103: 17-32(1967).

The yields of γ-transitions to the ground state and to four low-lying excited states were measured for the reaction ^{89}Y(p,γ)^{90}Zr between 11.9- and 13.5-MeV excitation energy. The strong fluctuations of the (p,γ$_0$) excitation curve indicate the admixture of higher-order configurations to the dipole resonances of ^{90}Zr. By means of the experimental ratios of the B(E1) values for transitions into the excited states and the ground state, the magnitude of the 2p-2h admixtures is estimated. (auth)

44678 THE HALF-LIVES OF NATURAL ^{176}Lu AND ^{180}Ta. Sakamoto, Koh (Tokyo Univ.). Nucl. Phys., A103: 134-44 (1967).

An extremely low-level gamma-ray spectrometer was used to measure gamma rays associated with the decay of naturally occurring ^{176}Lu and ^{180}Ta. For the half-life of ^{176}Lu, a new value of $5.0 \pm 0.3 \times 10^{10}$ yr was derived from single-crystal sum-coincidence spectra of high-purity lutetium oxide samples of natural isotropic abundance. A search was also made for possible cascade gamma rays following the electron capture of ^{180}Ta in a purified tantalum oxide by means of the usual gamma-gamma coincidence technique. Although the obtained spectra were slightly complicated by the presence of radioactive impurities in the sample, some positive evidence for ^{180}Ta decay was observed. The lower limit deduced for the half-life was $1.5 \pm 0.5 \times 10^{13}$ yr. (auth)

44679 L-ELECTRON CAPTURE DECAY OF ^{194}Hg. Crasemann, B.; Kostroun, Vaclav O.; Rao, P. Venugopala; Stephas, G. (Univ. of Oregon, Eugene). Contract AT(45-1)-1925. Nucl. Phys., A103: 145-52(1967). (RLO-1925-9).

The isotope ^{194}Hg was produced through the ^{194}Pt(α,4n) reaction with 70-MeV alpha particles, was separated chemically, and was identified through the gamma-ray spectrum of the daughter activity ^{194}Au. The ^{194}Hg photon spectrum contains Au L x rays. The absence of K x rays and gamma rays of measurable intensity immediately after separation indicates that this isotope decays by L, M, . . . electron capture to the ground state of ^{194}Au with an energy less than 81 keV. The half-life of ^{194}Hg was measured as 426 ± 50 day. The first-forbidden transition is exceptionally fast with $\log f_0 t \leq 5.8 \pm 0.1$. (auth)

44680 AN EXPERIMENTAL STUDY OF THE NUCLEI ^{147}Sm AND ^{149}Sm. Veje, E. (Univ. of Copenhagen). Nucl. Phys., A103: 188-202(1967).

Levels of ^{147}Sm and ^{149}Sm were studied by the (d,d'), (d,t) and, in the case of ^{149}Sm, also by the (d,p) reaction. The measurements were performed at 12 MeV bombarding energy, and the reaction products were analyzed in a high-resolution, broad-range, magnetic spectrograph. The ground-state transition Q-values were determined, and a number of previously unknown levels were observed. From the inelastic deuteron scattering cross sections, excitation multipolarities were deduced for transitions to 23 states in ^{147}Sm and for 28 transitions in ^{149}Sm. (auth)

44681 ENERGY-LEVEL STRUCTURE OF ^{131}Te FROM THE ^{130}Te(d,p)^{131}Te REACTION. Graue, A. (Univ. of Bergen); Jastad, E.; Lien, J. R.; Torvund, P.; Moore, W. H. Contract AT(30-1)-2098. Nucl. Phys., A103: 209-21(1967). (MIT-2098-339).

The ^{130}Te(d,p)^{131}Te reaction induced by 7.5-MeV deuterons was studied using the MIT broad-range multiple-gap spectrograph. More than 100 levels of ^{131}Te were identified up to 5.8-MeV excitation energy. Angular distributions were analyzed using DWBA calculations. The number of holes in the neutron shell observed were 1.0 in $2d_{\frac{5}{2}}$, 2.0 in $1h_{\frac{11}{2}}$, 0.32 in $3s_{\frac{1}{2}}$, and 0.12 in $2d_{\frac{3}{2}}$, respectively. These results are in fairly good agreement with pairing theory predictions. (auth)

44682 NON-LOCAL OPTICAL POTENTIAL FOR NEUTRON SCATTERING BY ^{208}Pb. Dotsenko, B. B.; Strizhak, V. I.; Terenetskii, K. O. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1357-9(Aug. 1966). (In Russian).

The earlier determined nature of the nonlocal optical potential is based on assumptions concerning interactions between incident particles and nuclei. The potentials derived for the twice magic nuclei ^{40}Ca and ^{208}Pb, in which there are no nucleon vacancies, have an actual "volume" and an "imaginary surface" portion. The proposed potential possesses geometric parameters, such as radius, diffusivity, and dynamic ones which characterize the interaction of the scattering particles with the filled shells; it is assumed that the latter one is the same for all nuclei. By using numerical calculations, concerning the elastic scattering characteristics of neutrons on ^{208}Pb, one dynamic and two geometric parameters were determined. The computation represents an advantage of this type of potential with respect to other forms of the optical potential. (TTT)

44683 LONG-RANGE ALPHA-PARTICLES AND HELIUM ISOTOPES IN THE THERMAL NEUTRON FISSION OF ^{239}Pu. Bollini, D.; Cambiaghi, M.; Fossati, F.; Pinelli, T. (Univ., Pavia, Italy. Istituto Nazionale di Fisica Nucleare, Pavia, Italy). Nuovo Cim. (10), 51B: 235-8(Sept. 11, 1967).

The energy spectrum of alpha particles released in thermal-neutron fission of ^{239}Pu was measured, and other helium isotopes produced were identified. A ratio of ^{6}He/^{4}He = 3×10^{-3} was found for production of the ^{4}He and ^{6}He isotopes. This is considered to be a lower limit for the ^{6}He yield. Evidence for ^{8}He production was obtained in 7 separate events, and 42 events above 12 MeV were distinguished for ^{3}He emission. The observed lower limit for the ^{3}He yield relative to emission of alpha particles was found to be 2.6×10^{-3}. Four events were observed in the region of ^{10}He, even though the stability of this nucleus seems unlikely. (S.F.L.)

44684 MECHANISM OF NUCLEAR TERNARY FISSION IN THE REACTIONS WITH HEAVY IONS. Muzychka, Yu. A.; Oganesyan, Yu. Ts.; Pustylnik, B. I.; Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 6: 306-10 (Aug. 1967). (In Russian).

A mechanism of ternary fission of heavy nuclei is considered. It is shown that the main contribution to ternary fission at high excitation energy is due to the "cascade fission" which means a binary asymmetrical fission of an initial nucleus followed by fission of the heavy fragment. An excitation function is obtained for the cascade fission for the reactions ^{238}U(^{22}Ne, 3f); ^{209}Bi(^{40}Ar, 3f); and ^{238}U(^{40}Ar, 3f). (auth)

44685 DETERMINATION OF THE RATE OF THE ^{130}Te DOUBLE β^- DECAY. Gerling, E. K.; Shukolyukov, Yu. A.; Ashkinadze, G. Sh. (Lab. of Precambrian Geology, Leningrad). Yadern. Fiz., 6: 311-15(Aug. 1967). (In Russian).

The techniques of stripping, rectification, and isotope analysis of microquantities of Xe are outlined. The total Xe contents in tellurium bismuthite are determined to be $(1.56 \times 0.03) \cdot 10^{-10}$ cm^3/g. The isotopic contents in the gas fractions stripped by the gradual temperature increase up to 1400°C are also determined. Xenon extracted from the tellurium bismuthite is a mixture of three components: atmospheric Xe, Xe from the spontaneous fission of U, and Xe from nuclear reactions on Te nuclei. The corresponding corrections to the ^{130}Te contents are introduced. The half-life for the double β^- decay of ^{130}Te is calculated from the concentration of ^{130}Xe, the known concentration of ^{130}Te, age, and the calculated conservation coefficient for ^{130}Xe inside the mineral structure. The result is $(3.0 \pm 0.4) \times 10^{20}$ years. The lower limit to the half-life for the double β^- decay of ^{128}Te is found to be 7.7×10^{20} years. (auth)

44686 THE ISOBARIC CHAIN OF MASS 98: ^{98}Zr → ^{98}Nb → ^{98}Mo IN THE FISSION OF ^{235}U BY THERMAL NEUTRONS. Hubenthal, Karlheinz (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 264: 1468-71(May 22, 1967). (In French).

Evidence was obtained of the presence of the 2.8-sec isomer of ^{98}Nb, the principal branch of the isobaric chain A = 98 in the fission of ^{235}U. Fast chemical separations made it possible to attribute to ^{98}Zr a half-life of 31 sec. The 2.8-sec. isomer of ^{98}Nb thus obtained has a radiation identical to that obtained by ^{98}Mo(n,p)^{98}Nb. (tr-auth)

44687 α DECAY AT HIGHLY EXCITED STATES IN SAMARIUM ISOTOPES. Kvitek, I.; Popov, Yu. P. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1371-4(Aug. 1966). (In Russian).

Study of the usually low-energy α decay from the excited nuclear states of rare-earth elements is expected to yield results more conveniently because the excitation makes it easier to pass through the Coulomb barrier, even when strong γ transitions take place simultaneously. For this reason, the α decay from various excited states of ^{148}Sm and ^{150}Sm isotopes was investigated by means of a xenon scintillation detector, placed in the neutron beam of the reactor of the Joint Institute for Nuclear Investigations. The energy of the neutrons was determined by the time-of-flight method. The ^{150}Sm state has a spin and parity of 4$^-$ and possesses an average $\overline{G}_\alpha = 7.4 \times 10^{-6}$ eV. The levels of ^{148}Sm with $E_0 = 3.4$ and 18.3 eV possess times of flight differing by almost an order of magnitude. The spins of the other levels are not known and their lifetimes with respect to the α decay fluctuate within one order of magnitude. (TTT)

44688 INVESTIGATION OF α SPECTRA OF Bi ISOTOPES. Makhunka, I.; Tron, L.; Fenesh, T.; Khalkin, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1375-8(Aug. 1966). (In Russian).

In the mass number range of 199 < A < 209, the α decay probability of bismuth isotopes is low because the number of neutrons in these nuclei is equal to or less than the magic number 126; only ^{199*}Bi, ^{201*}Bi, ^{203*}Bi, and ^{209}Bi were found to possess α activity. In order to supplement these findings, the α activity of neutron deficient isotopes, obtained by the Pb(p,xn)Bi reaction, was investigated by means of a Si type semiconductor α spectrophotometer. The neutron-deficient isotopes were formed in the internal beam of the Institute's synchro-cyclotron by 140-MeV protons and a natural lead target; at the same time polonium was obtained from the lead by the secondary (α,xn) reaction or from the bismuth impurity by the (p,xn) reaction. The measurements were completed within 100 min after the end of the irradiation. Studies in the 4.9 to 5.2 MeV range on the decay of the ground state of ^{200}Bi and the metastable ^{202*}Bi indicated that the ratio of the extrapolated intensities $[I_0(^xBi)/I_0(^{201*}Bi)] < 10^{-2}$, whereby x designates the ground state of isotope 200 or the metastable state of isotope 202. The data agree with previous findings but the half-life of ^{199*}Bi was found to be 24.70 ± 0.15 min, indicating the existence of an isomeric state of ^{199}Bi. (TTT)

44689 DETERMINATION OF THE ^{93}Mo HALF LIFE FROM THE YIELDS OF NUCLEAR REACTIONS. Dmitriev, P. P.; Konstantinov, I. O.; Krasnov, N. N. Yadern. Fiz., 6: 209-11 (Aug. 1967). (In Russian).

The half-life of ^{93}Mo was determined by comparing the yields of the nuclear (d,2n) reactions in the mass region A ~ 100 with the PEI cyclotron (E_d = 21 MeV). The result is $T_{\frac{1}{2}}$ = 3000 ± 600 years. The yields of the following nuclear reactions are presented: ^{85}Rb(d,2n)^{85}Sr, ^{93}Nb(d,2n)^{93}Mo, ^{103}Rh(d,2n)^{103}Pd, and ^{109}Ag(d,2n)^{109}Cd. (auth)

44690 INVESTIGATION OF GAMMA RAYS FROM ^{188}Pt BY MEANS OF SPECTROMETER WITH A Ge–Li DETECTOR. Kotelnikov, G. A.; Kryukova, L. N.; Kordyukevich, V. O. (Inst. of Nuclear Physics, Moscow). Yadern. Fiz., 6: 212-18(Aug. 1967). (In Russian).

A spectrometer with Ge – Li detectors was used to study the ^{188}Pt gamma rays produced in the spallation of Au induced by protons from the JINR synchrocyclotron. A high resolution (3.5 to 4 keV) made it possible to observe for the first time a number of complex gamma lines and to estimate their energies and relative intensities. The gamma transitions 55, 114, 133, 140, 170, 187, 195, 282, 308, 382, 424, 478 were found and the transitions 122, 222, and 230 keV are proposed to exist in ^{188}Ir. The conversion coefficients α_k and multipolarities of some gamma transitions were obtained by comparison of the measured gamma-line intensities with the results obtained from ^{188}Pt conversion electron spectra. The proposed ^{188}Pt decay scheme was confirmed by the data obtained. (auth)

44691 THE SPONTANEOUS FISSION OF ISOTOPE ^{254}102. Flerov, G. N.; Kuznetsov, V. I.; Skobelev, N. K. At. Energ. (USSR), 22: 494-5(June 1967). (In Russian).

The 6-sec half-life found experimentally for the spontaneous fission of isotope ^{254}102 was not anticipated by theory. Later experiments revealed that the isotope undergoes α decay with a half-life of about 60 sec and an energy of E_α = 8.11 ± 0.03 MeV. In order to determine the partial half-life with respect to spontaneous fission, an attempt was made to determine the spontaneous fission cross section σ_{sf}, irradiating a ^{238}U target for 3.5 min with about 130-MeV ^{22}Ne ions. The energy loss within the target amounted to about 9 MeV. As a result of an integral dose of 3.34×10^{17} ^{22}Ne ions, 20 tracks were obtained; of these, not more than one-half could be attributed to be ^{254}104, yielding a value of $\sigma_{sf} < 2 \times 10^{-35}$ cm^2. From this and the averaged σ_α value of the ^{238}U(^{22}Ne,6n)^{254}102 reaction, it was calculated that the half-life of the ^{254}104 isotope with respect to spontaneous fission is at least 25 hours. (TTT)

44692 MEASUREMENT OF BETA-NEUTRINO ANGULAR CORRELATION USING NUCLEAR RESONANCE FLUORESCENCE. Palathingal, J. C. (Univ. of Pennsylvania, Philadelphia. Univ. of Cincinnati). Phys. Rev., 161: 1045-9(Sept. 20, 1967).

The experimental details of a measurement of the β-neutrino angular correlation of ^{122}Sb (results reported earlier) using nuclear resonance fluorescence of the cascade γ-rays are presented. The angular correlation function, which depends on the β-decay nuclear matrix elements, can be directly obtained from the yields of the resonance-scattered γ radiation in coincidence with β rays of selected energies. The advantages and the limitations of an experiment of this type are discussed. (auth)

44693 LIFETIMES OF THE 91- AND 531-keV STATES IN ^{147}Pm. Rama Rao, M. T.; Ramamurty, V. V.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Phys. Rev., 161: 1290-3 (Sept. 20, 1967).

The lifetimes of the 91- and 531-keV states in ^{147}Pm, populated in the β decay of ^{147}Nd, were determined employing a time-to-pulse-height converter arrangement similar to that of Green and Bell. The half-life of the 91-keV state, determined by the slope method, yielded a value 2.46 ± 0.07 nsec. The mean-life of the 531-keV state, determined by the centroid-shift method, yielded a value $(1.2 \pm 0.22) \times 10^{-10}$ sec. These values are employed to determine the M1 and E2 transition probabilities, and are compared with the values obtained from the single-particle estimates and the values estimated by employing the Kisslinger-Sorensen-type wave functions and also those of Choudhury and O'Dwyer for the ground and the 91-keV states of ^{147}Pm. From the experimental transition probabilities the 531-keV state is inferred to contain sizable parts of the $\frac{7}{2}^+$ phonon and the $\frac{5}{2}^+$ phonon contributions. (auth)

44694 ON-LINE ALPHA SPECTROSCOPY OF NEUTRON-DEFICIENT RADIUM ISOTOPES. Valli, Kalevi; Treytl, William; Hyde, Earl K. (Univ. of California, Berkeley). Phys. Rev., 161: 1284-9(Sept. 20, 1967). (UCRL-17322).

Isotopes of radium lighter than mass 215 were studied by bombardment of ^{206}Pb with ^{12}C and ^{197}Au with ^{19}F. Si(Au) surface-barrier detectors were used in on-line measurements to measure α-decay characteristics. Mass-number assignments of ^{214}Ra through ^{206}Ra were made on the basis of excitation functions and genetic relations with Fr, emanation, and At isotopes. Half-lives and accurate α energies were determined for the Ra isotopes, and the α energy of ^{214}Fr was corrected. α and β branchings were measured for ^{213}Ra and ^{214}Ra. Some systematic trends in the α-decay energies were interpreted in terms of weakening neutron and proton pairing energies near closed shells. (auth)

44695 TERNARY FISSION OF ^{236*234*}U. Muga, M. L.; Rice, C. R.; Sedlacek, W. A. (Univ. of Florida, Gainesville). Phys. Rev., 161: 1266-83(Sept. 20, 1967). (ORO-2843-10).

A detailed study of the ternary fission of ^{236*}U and ^{234*}U was completed using a triple-coincidence technique and a three-parameter energy measurement on the product fragments. Arguments based on experimental energy, angular, and frequency correlations are presented for elimination of phenomena other than ternary fission as explanations of the observed data. Among possible interfering effects considered were accidental events, instrumental malfunctions, and scattering phenomena. In connection with the third factor, an experimental determination of the characteristics of binary-fission-fragment scattering confirmed the absence of this phenomenon from all but one of the angular arrangements investigated. It is concluded that the major portion of triple events observed arises from a ternary-fission process. A difference in the ternary-fission properties of ^{236*}U and ^{234*}U is interpreted as caused by the dominant effect of underlying shell structure in forming the product fragments, an effect which may result in the formation of unique (preselected) fragments masses. Mass distributions indicate the formation of low-mass fission products with mass peaks centered near 30 and 50 amu. A qualitative mechanism by which the ternary-fission process may occur is presented. (auth)

44696 NUCLEAR-STRUCTURE STUDIES WITH (d,p) REACTIONS ON ^{106}Pd AND ^{108}Pd. Cohen, B. L.; Moorhead, J. B.; Moyer, R. A. (Univ. of Pittsburgh). Phys. Rev., 161: 1257-65 (Sept. 20, 1967).

Energy distributions of protons emitted at various angles from 12-MeV-deuteron-induced (d,p) reactions on ^{106}Pd and ^{108}Pd were measured with 7-keV energy resolution using an Enge split-pole

spectrograph. The results for the two isotopes are very similar except that summed spectroscopic factors are a little smaller in ^{108}Pd, as expected from the fact that it has more neutrons. The level densities were found to be about 25 levels per MeV, and the single-particle levels are fragmented over a wide range of energies, although a large fraction of the strength of single-particle levels in the 50-82 shell is always in the lowest-lying nuclear level. The l = 4 strengths seem to be too large, and the (d,p)/(d,t) cross-section ratio of one of these states in each isotope indicates that it may be $g_{\frac{9}{2}}$ rather than $g_{\frac{7}{2}}$; the $h_{11/2}$ strengths are too small. Possible explanations for this are discussed, including the possibility that these nuclei are strongly deformed. The s and d states are somewhat more full in ^{108}Pd than in its isotope ^{112}Sn. (auth)

44697 ENHANCED E3 TRANSITION IN ^{137}La. Van Hise, J. R. (Oak Ridge National Lab., Tenn.); Chilosi, G.; Stone, Nicholas J. Phys. Rev., 161: 1254-7(Sept. 20, 1967). (ORNL-P-2383).

Using time-to-amplitude conversion techniques, the half-life of the 1004-keV level in ^{137}La was found to be $\leq(0.41 \pm 0.07)$ nsec. This upper limit also applies to the 836- and 926-keV levels. The 1004-keV level is depopulated by 168-, 994-, and 1004-keV γ-ray transitions. Using the corresponding experimental (previously known) branching ratios from this level, the partial half-life of the 994-keV transition, which is of E3 character, is $\leq(0.14 \pm 0.03)$ μsec. The enhancement factor ($\tau_{Weisskopf}/\tau_{obs}$) is ≥7.8. This result is compared with other E3 rates. The half-life of the 168-keV transition of E1 character from the 1004-keV level was found to be $\leq(0.45 \pm 0.1)$ nsec with a resulting enhancement factor of $\geq 0.45 \times 10^{-4}$. The half-life of the 1004-keV transition is $\leq(10.3 \pm 0.3)$ nsec; its character is M2 or M2-E3, and the resulting enhancement (assuming all M2) is $\geq 1.12 \times 10^{-2}$. (auth)

44698 NUCLEAR RESONANCE FLUORESCENCE IN ^{193}Ir. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Phys. Rev., 161: 1249-53(Sept. 20, 1967). (NYO-3525-18).

The high-speed-rotor technique was used to tune some of the γ rays accompanying the decay of ^{193}Os to the corresponding excited states of ^{193}Ir. Resonant scattering experiments established that the previously reported 559-keV level in ^{193}Ir is a doublet. High-resolution Ge(Li) spectrometry led to a value $\Delta E = 1.9 \pm 0.1$ keV for the energy separation of the two components of this doublet, and to a ratio I(557) : I(559) = 3.0 ± 0.6 for the intensities of the corresponding ground-state transitions in the ^{193}Os decay. From a comparison of resonance scattering and self-absorption results, it was concluded that the 559-keV level was responsible for most of the resonant scattering from the doublet, and that this level exhibited considerable branching to the 139-keV excited state. Assuming spins of $\frac{3}{2}$, $\frac{1}{2}$, and $\frac{5}{2}$ for the 460-, 557-, and 559-keV excited states of ^{193}Ir, and ground-state branching ratios Γ_0/Γ of 0.48, 0.73, and 0.73, respectively, the following level widths were obtained: $\Gamma_{460} = (3.3 \pm 0.6) \times 10^{-5}$ eV; $\Gamma_{557} < 1.8 \times 10^{-4}$ eV; $\Gamma_{559} = (3.7 \pm 0.8) \times 10^{-4}$ eV. (auth)

44699 NEUTRON SPECTRA FROM MONOENERGETIC PHOTONS ON BISMUTH. Kuchnir, F. T.; Criegee, Axel L.; Drake, D. M.; Hanson, A. O.; Sutton, D. C. (Univ. of Illinois, Urbana). Phys. Rev., 161: 1236-48(Sept. 20, 1967).

Spectra of photoneutrons from a ^{209}Bi target were obtained in the electric dipole giant-resonance region (12 to 16 MeV). A γ-ray energy resolution of 1.5% was attained using a bremsstrahlung monochromator; the neutron energies were measured with a time-of-flight technique with a resolution which varied from 10% at 2 MeV to 15% at 6 MeV. About 88% of the neutrons ejected by 14-MeV γ rays are statistical. The inferred level density of ^{208}Bi near its ground state is not a simple function of excitation energy, but from 4 to 7 MeV it increases exponentially with energy; in that energy range the temperature is about 1 MeV. The nonstatistical high-energy neutrons leave the ^{208}Bi nucleus at the excitation energies at which the states are well represented as single-neutron holes in ^{209}Bi. These high-energy neutrons are intimately connected with the giant resonance. If the giant resonance is dominated by a single dipole state, the absolute width which characterizes the decay of the dipole state into the compound nucleus must increase by a factor of about 3 between 12 and 16 MeV. (auth)

44700 M1 TRANSITION PROBABILITIES IN ODD-MASS DEFORMED NUCLEI. Seaman, G. G.; Bernstein, E. M.; Palms, J. N. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 161: 1223-32(Sept. 20, 1967). (LA-DC-8747).

The odd-mass deformed nuclei ^{153}Eu, ^{159}Tb, ^{165}Ho, ^{169}Tm, ^{175}Lu, and ^{181}Ta were studied by Coulomb excitation with 50-MeV oxygen ions. The branching ratios for the de-excitation of levels in the ground-state rotational bands were determined by measuring the γ-ray intensities in singles spectra observed with a Ge(Li) detector. M1 transition rates were obtained from the branching ratios with the assumption that the rotational-model predictions for the E2 transition rates are correct. For ^{159}Tb, six M1 transition rates are compared. In all cases the M1 transition rates agree with rotational-model theory within experimental error. Absolute E2 transition rates were also measured for some of the vibrational and intrinsic states observed. (auth)

44701 STRUCTURE OF ^{208}Pb DETERMINED BY THE (d,p) REACTION. Bardwick, John; Tickle, Robert (Univ. of Michigan, Ann Arbor). Phys. Rev., 161: 1217-22(Sept. 20, 1967). (COO-1112-83).

The structure of the doubly magic nucleus ^{208}Pb was investigated using the reaction ^{207}Pb(d,p)^{208}Pb with a deuteron bombarding energy of 21.6 MeV. Proton angular distributions in the interval 10 to 80° were measured for more than twenty levels up to 6 MeV excitation in ^{208}Pb. The experimental results were analyzed to extract the factors $(2J + 1)S_{lj}$, an important link between experiment and theory. An interesting feature of the data analysis is the use of ^{208}Pb(d,p)^{209}Pb angular distributions to obtain the necessary reduced cross sections rather than obtaining them from a distorted-wave Born analysis calculation as is usually the case. (auth)

44702 STUDY OF INELASTIC SCATTERING OF PROTONS FROM ^{116}Sn, ^{122}Sn, AND ^{124}Sn AT ISOBARIC ANALOG RESONANCES. Schneid, E. J.; Hamburger, E. W.; Cohen, B. L. (Univ. of Pittsburgh). Phys. Rev., 161: 1208-16(Sept. 20, 1967).

Inelastic scattering of protons from targets of ^{116}Sn, ^{122}Sn, and ^{124}Sn was studied with solid-state detectors at the resonances which are isobaric analog states of the $s_{\frac{1}{2}}$ and $d_{\frac{3}{2}}$ single-quasiparticle states of ^{117}Sn, ^{123}Sn, and ^{125}Sn, respectively. Angular distributions were measured on and off the resonances. Sums of inelastic partial widths $\Sigma\Gamma_{p'}$ are extracted from the data and compared with theoretical predictions from the shell-model calculations of Baranger, Baranger, and Kuo; the over-all agreement is quite good. In particular, the strong transitions observed to excited states at approximately 2.5-MeV excitation in the target nucleus are predicted by the theory. The transition to the collective 3^- state does not show resonances. (auth)

44703 ELASTIC SCATTERING OF ^{12}C, ^{14}N, AND ^{16}O BY ^{208}Pb, AND OF ^{16}O BY ^{209}Bi. Baker, S. D.; McIntyre, J. A. (Yale Univ., New Haven). Phys. Rev., 161: 1200-7(Sept. 20, 1967). (YALE-2726-H-95).

Differential cross sections were measured for elastic scattering of ^{12}C, ^{14}N, and ^{16}O by ^{208}Pb and of ^{16}O by ^{209}Bi. A phase-shift analysis of the data was made to evaluate the nuclear interaction radius R and the "surface thickness" for the interaction ΔR. The interaction-radius parameter r_0 was found to be 1.44 ± 0.03 F for all four scattering experiments, where $R = r_0(A_1^{\frac{1}{3}} + A_2^{\frac{1}{3}})$, the A_i being the nuclear masses of the two nuclei involved in the scattering process. In contrast to the constant value found for r_0, the "surface thickness" was found to be 0.31 ± 0.02 F for the ^{14}N scattering, 0.42 ± 0.04 F for the ^{16}O scattering on both ^{208}Pb and ^{209}Bi, and 0.49 ± 0.05 F for the ^{12}C scattering. It is not clear why these "surface thicknesses" differ as they do. (auth)

44704 MAGNETIC MOMENTS OF THE FIRST EXCITED 2^+ STATES IN THE EVEN Pt ISOTOPES. Kalish, R. (Massachusetts Inst. of Tech., Cambridge); Grodzins, L.; Borchers, R. R.; Bronson, J. D.; Herskind, B. Phys. Rev., 161: 1196-1200(Sept. 20, 1967). (MIT-2098-311; COO-7-0415).

Integral precession measurements for the first excited 2^+ states in ^{194}Pt, ^{196}Pt, and ^{198}Pt are reported. The levels were Coulomb excited by back-scattered oxygen ions, with the excited nuclei recoiling into a polarized iron backing. By combining the present measurement of ωτ for ^{194}Pt with earlier radioactivity measurements, the effective internal magnetic field acting on the Pt nuclei implanted in the iron host was deduced to be $H_{int}(recoil) = (-0.89 \pm 0.07) \times 10^6$ G. The g factors for ^{194}Pt, ^{196}Pt, and ^{198}Pt deduced from the measured precession angles and from the above value of the internal field are found to be 0.32 ± 0.04, 0.27 ± 0.04, and 0.28 ± 0.04, respectively. (auth)

44705 DISTRIBUTION OF MASS AND CHARGE IN THE FISSION OF ^{245}Cm. von Gunten, H. R.; Flynn, K. F.; Glendenin, L. E. (Argonne National Lab., Ill.). Phys. Rev., 161: 1192-5 (Sept. 20, 1967).

The distribution of mass and charge in thermal-neutron-induced fission of ^{245}Cm was investigated by radiochemical determination of the fission yields for 34 mass chains and 2 shielded nuclides (independent yields). ^{245}Cm is the heaviest nuclide fissionable by thermal neutrons to be investigated in this manner. The mass distribution is asymmetric; the heavy-mass group is centered at about the same position as in all previously investigated cases of low-energy fission, while the light-mass group is shifted to a higher mass number. The fission-yield data for ^{245}Cm indicate a

value of 4 ± 1 for $\bar{\nu}$, the average number of neutrons emitted per fission. The division of nuclear charge, as indicated by the independent yields of the shielded nuclides, adheres to a pattern characteristic of low-energy fission. A comparison of mass distributions in thermal-neutron-induced fission, reactor-neutron-induced fission, and spontaneous fission for several fissioning nuclei is given. (auth)

44706 PULSED-BEAM MEASUREMENTS OF THE NUCLEAR g FACTORS OF THE 2+ ROTATIONAL STATES IN ^{150}Nd, ^{162,164}Dy, ^{166,168,170}Er AND ^{180}W. Kurfess, J. D.; Scharenberg, R. P. (Case Inst. of Tech., Cleveland). Phys. Rev., 161: 1185-91 (Sept. 20, 1967). (COO-1573-9).

The nuclear g factors and mean lives of the 2+ rotational states of ^{150}Nd, ^{162}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, ^{170}Er, and ^{180}W were measured by the pulsed-beam technique. The time differential precession of the angular distribution of the de-excitation γ radiation was measured following Coulomb excitation by a pulsed proton beam. Metallic neodymium targets and dysprosium–copper and erbium–copper eutectic targets were used at about 900°C. Paramagnetic correction factors for free tripositive ions were used in the g-factor calculations. Strong perturbations causing an exponential attenuation of the anisotropy of the angular distribution were observed in the liquid targets. These perturbations are interpreted to be magnetic in character, and the 4f-electron-shell spin-lattice relaxation times are determined. A metallic tungsten target at room temperature was used for the ^{180}W experiments. The g factor and mean-life results are: g = 0.310 ± 0.021, τ = 2.191 ± 0.034 nsec for the 132-keV state in ^{150}Nd; g = 0.362 ± 0.024, τ = 3.157 ± 0.050 nsec for the 81-keV state in ^{162}Dy; g = 0.321 ± 0.025, τ = 3.444 ± 0.054 nsec for the 73-keV state in ^{164}Dy; g = 0.329 ± 0.027, τ = 2.696 ± 0.042 nsec for the 81-keV state in ^{166}Er; g = 0.344 ± 0.028, τ = 2.664 ± 0.042 nsec for the 80-keV state in ^{168}Er; g = 0.329 ± 0.025, τ = 2.734 ± 0.042 nsec for the 79-keV state in ^{170}Er; and g = 0.351 ± 0.030, τ = 1.61 ± 0.03 nsec for the 122-keV state in ^{180}W. (auth)

44707 ANGULAR CORRELATION OF INELASTIC SCATTERING IONS AND γ QUANTA EMITTED BY COULOMB EXCITATION OF ^{97}Mo, ^{105}Pd, AND ^{135}Ba. Gal'perin, L. N.; Gusinskii, G. M.; Lemberg, I. Kh. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1221-7 (July 1966). (In Russian).

Study of the angular correlations of inelastically scattered ions and γ quanta emitted as a result of Coulomb excitation of nuclei and subsequent de-excitation of the excited states yields information on the spin of these states and the relative intensity of the E2 and M1 transitions. The method based on the coincidence of γ quanta and heavy ions (γI coincidence) makes it possible to determine as a result of angular correlation measurements high-background γ spectra because the use of the coincidence method attenuates the background. The method is also useful to determine γγ correlation coefficients and to measure the spin of the excited state. The strong anisotropy of the angular correlation function helps to increase the precision of the determinations. The particles must be accelerated to energies close to the Coulomb barrier of the investigated nucleus, keeping in mind that secondary processes such as reorientation of the nucleus of the target in the field of the incident particles changes the angular correlation function. In the experiments the scattered ions were recorded in the range from 149.5 to 166.8° by means of a circular, p-n silicon detector, recording the γ quanta by 2 scintillation counters placed at 0 and 60° with respect to the incident ion beam. The measurements were carried out with ^{97}Mo, ^{105}Pd, and ^{135}Ba, comparing the data obtained with earlier findings. (TTT)

44708 MULTIPOLE RADIATIVE TRANSITIONS IN ^{191}Os AND ^{191*}Os DECAY. Mazets, E. P.; Sergeenkov, Yu. V. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1193-6(July 1966). (In Russian).

Although the existence of two levels of ^{191}Ir formed during the β decay of ^{191}Os and of the isomeric ^{191*}Os states were confirmed earlier, the data concerning the multipolarity of radiative transitions to the ground state are contradictory. The disagreement in the reported data is due to the poor resolution of the lines in the internal conversion electron spectra and incorrect intensity determinations; therefore, the internal conversion electron spectra of ^{191}Os and ^{191*}Os were studied with a high-resolution (0.08%) β spectrometer. The metallic natural osmium sources used in the experiments were prepared by cathodic sputtering on an aluminum foil, exposing them to reactor beam. In addition to the L and M isomeric conversion lines, others belonging to the decay of ^{193}Os were found in the spectrum of ^{191}Os. The isomeric transition energy was found to be 74.38 ± 0.01 keV; it amounted to 73.07 ± 0.01 and 138.96 ± 0.02 for the γ transitions in ^{193}Ir. The multipolarity of the γ transitions was determined by comparing the intensity of the lines with theoretical values. The isomeric transition in ^{191}Os appears to possess a compound nature: 99.1 ± 0.1% M3 + 0.9 ± 0.1% E4. Measurements in the M subshells confirmed the multipolarity of E3. The intensity of the 82.52 ± 0.03-keV γ transition line was too low to carry out measurements. (TTT)

44709 SPECTRUM OF INTERNAL CONVERSION ELECTRONS EMITTED IN THE REACTION ^{186}W(n,γ)^{187}W. Prokof'ev, P. T.; Simonova, L. I. (Inst. of Physics, Riga). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1210-12(July 1966). (In Russian).

The conversion-electron spectrum obtained during the thermal neutron capture by ^{186}W nuclei was determined in the 35 to 300-keV range by means of a magnetic β spectrometer. The metallic tungsten used in the experiments as a target contained 0.5% ^{180}W, 0.2% ^{182}W, 0.6% ^{183}W, 2.7% ^{184}W, and 96% ^{186}W. The relative intensities of the strong and weak lines were determined with errors of 20 and 50%, respectively; the multipolarity was derived from intensity relations of the lines of the L subshell. On the basis of the data obtained, a scheme was proposed for the lower levels of ^{187}W. It was found that the ground state of the ^{186}W nucleus has a 0^+ spin and parity; the ^{187}W nucleus formed by thermal neutron capture has a $\frac{1}{2}^+$ state. As a result of this charge from this level low-spin levels were expected. The results also indicated the existence of a 204.6-keV level with $K = \frac{1}{2}$, $I^\pi = \frac{3}{2}^-$. The $\frac{1}{2}^-$, 302.5-keV state of the rotational band with $K^\pi = \frac{1}{2}^-$ was obtained in the 304-keV (dp) reaction from the sum of the (77.0 + 225.5)-keV transitions. The calculated parameters of the rotational band with $K^\pi = \frac{1}{2}^-$ were: A = 19.6 ± 0.1; a ≈ 0. It was not possible to identify the lower, $\frac{1}{2}^-$ excited states which appear in the (d,p) reaction from the conversion-electron spectra. (TTT)

44710 $\beta^+\gamma$ COINCIDENCES IN ^{160*}Ho DECAY. Dzhelepov, B. S.; Kraft, O. E.; Naumov, Yu. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1127-9(July 1966). (In Russian).

The spin of a deformed nucleus may be determined by estimating the relative probability of its β decay to the rotational band of the daughter nucleus, assuming that the quantum characteristics of the latter are known. This method was used for the ^{160*}Ho nucleus which undergoes positron decay with a limiting β energy of 2280 keV and an intensity of 0.012% for the decay leading to the lower rotational band of the even-even ^{160}Dy nucleus, the β transition intensities to the 0^+, 2^+, and 4^+ levels of ^{160}Dy are not known. Therefore, the $\beta^+\gamma$ coincidences were measured for ^{160*}Ho by means of a magnetic coincidence spectrometer, using the ^{160}Er obtained by bombarding a Ta target with 660-MeV protons as the source of ^{160*}Ho. A β spectrometer was used to separate the ~1590-keV positrons, measuring the coincidences between these positrons with γ rays in the energy range between 10 to 250 keV. Coincidences of the separated positrons with 87-keV γ rays and 45-keV K peaks were observed. The ratio of the areas of the peaks was found to be 1.7 ± 0.4, which is close to the theoretical value of $\alpha_K = 1.6$ of the E2 transition of Dy. It was thus established that the β^+ decay of ^{160*}Ho leads to the 2^+ level of ^{160}Dy. The spin of ^{160*}Ho is very probably I = 2 which agrees with 2^- characteristics usually attributed to the ^{160*}Ho nucleus. (TTT)

44711 $\beta^+\gamma$ COINCIDENCE IN THE DECAY OF ^{188}Ir. Dzhelepov, B. S.; Zaitseva, N. G.; Kraft, O. E.; Naumov, Yu. V.; Sigalov, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1124-6(July 1966). (In Russian).

The properties of the ^{188}Ir nucleus which occupies an intermediary position between deformed and spherical nuclei are difficult to predict on the basis of currently proposed models. In order to obtain information concerning the spin of the nucleus, the $\beta^+\gamma$ coincidences during the decay were measured. The isotope decays by electron capture and positron emission to ^{188}Os. It was assumed that the 1656-keV component passes on the level of the lower rotational band of ^{188}Os. The measurement involved determination of the coincidences of the hard component of the β^+ of the ^{188}Ir spectrum with γ rays, using a ^{188}Pt source, separating out the Pt fraction containing ^{188}Pt and its daughter, ^{188}Ir, from a proton-irradiated gold target within 48 hrs after irradiation. The amount of ^{189}Ir in the source did not interfere with the measurements. The data indicated that the most probable value of the ground-state spin of ^{188}Ir is I = 2. If it were I = 0, the β^+ decay to the 0^+ level of ^{188}Os should have a higher intensity than to the 2^+ level. For I = 1, the ratio of the β^+ decay to the 0^+ and 2^+ levels should be 2 or 0.5, which does not agree with experimental data. Similar considerations prevail for I = 3, for which β transitions to the lower potential band of the ^{188}Os are forbidden. (TTT)

44712 K-FORBIDDEN β TRANSITIONS IN ^{160}Tb DECAY. Dzhelepov, B. S.; Kraft, O. E.; Mikhailov, V. M.; Naumov, Yu. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1159-66(July 1966). (In Russian).

The β spectrum of ^{160}Tb nucleus is assumed to contain two components, one of which goes to the 2^+ level and the other to the 3^+ level. Measurement of the transition probabilities of the 2^+ and 4^+

levels of the ground band yielded a value of 2.8 ± 0.7. The βγ coincidences were measured by means of a magnetic coincidence spectrometer; the coincidence of 10- to 400-keV γ quanta with electrons of the desired energy were recorded by a γ spectrometer. The multipolarity λ of the β transition was determined by comparing the ratio of β transition probabilities to the 2^+ and 4^+ levels of the ground band of ^{160}Dy with the theoretical ratios. For transitions with λ = 1 and λ = 2, the theoretical ratios of transition probabilities from the 3^- level of ^{160}Tb to the 2^+ and 4^+ levels of ^{160}Dy are 1.33 and 2.5, respectively. The experimental value found for the latter was 2.8 ± 0.7. The analytical study revealed that the absolute value of the K-forbidden β transitions from the ground state of ^{160}Tb to the ground-state rotational band of ^{160}Dy may be attributed to the presence of impurities in the original and final states for a multipolarity of λ = 2. (TTT)

44713 STUDIES OF γ SPECTRA AND IDENTIFICATION OF NEUTRON-DEFICIENT OSMIUM ISOTOPES. Belyaev, B. N.; Gvozdev, B. A.; Gudov, V. I.; Kalyamin, A. V.; Krizhanskii, L. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1150-8(July 1966). (In Russian).

The osmium isotopes are of great special interest because they are at the boundary of the group of greatly deformed nuclei with high-lying rotational levels. A study was undertaken to identify reliably osmium isotopes with mass numbers of A = 180 and 181 and to study their γ spectra, preparing these neutron-deficient isotopes on the basis of the Yb(^{12}C,Xn)Os and Tm(^{15}N,Xn)Os reactions by bombarding ytterbium and thulium targets with ^{12}C and ^{15}N ions, respectively. The targets consisted of electrodeposited rare-earth oxides on an aluminum foil. The γ radiation of separated osmium was investigated by means of a scintillation spectrometer with a 10 to 12% resolution. The yields of ^{183}Os and ^{182}Os isotopes obtained by the irradiation of enriched osmium isotopes confirmed previous data. The ^{181}Os isotope was obtained by the (^{12}C, 5n) reaction of ^{174}Yb; a strong γ radiation with E_γ = 130, 250, 815 keV ($T_{½}$ = 2.5 hours) was observed in this case. The results also confirmed previous identification of ^{180}Os, formed by the bombardment of ^{169}Tm with 100-MeV ^{15}N ions. It was also obtained by the ^{172}Yb(^{12}C,4n)^{180}Os and, with a smaller yield, the ^{174}Yb(^{12}C,6n)^{180}Os reactions. The γ spectra of these isotopes were also determined. (TTT)

44714 MULTIPOLE TRANSITIONS WITHIN THE $K^\pi = 4^-$ BAND IN ^{168}Er. Bondarenko, V. A.; Prokof'ev, P. T. (Inst. of Physics, Riga). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1173-5 (July 1966). (In Russian).

A 1095-keV level was discovered earlier by the authors while studying the ^{168}Tm → ^{168}Er decay; this two-neutron level possesses a 4^- character with a [633↑ + 521↓] configuration. The transitions within this rotational band exhibit a very low M1 multipolarity in transitions with spin changes to unity. Therefore, the ratio of the M1 and E2 transitions with ΔI = 1 were examined by studying internal conversions. A magnetic β spectrograph was used in the 30- to 300-keV electron energy range with erbium oxide targets enriched in ^{167}Er. The transitions to the 1095-keV level were found to be intensive because the competing transitions from the ground-state rotational band level and the γ-vibrational level are forbidden. In the (n,γ) reaction, the level population was found to differ from that observed in β decay. The results confirmed that only pure E2 transitions occur in the $K^\pi = 4^-$ level. The largest possible M1 multipolarity amounts to $\delta^2 = 1.5$. (TTT)

44715 LEVELS EXCITED IN ^{206}Pb WITH BOTH TWO-NEUTRON STRIPPING AND PICKUP REACTIONS. Flynn, E. R. (Los Alamos Scientific Lab., N. Mex.); Igo, G. J.; Woods, R.; Barnes, P. D.; Glendenning, Norman K. Phys. Rev. Lett., 19: 798-801(Oct. 2, 1967). (LA-DC-8565).

The energy levels of ^{206}Pb were investigated using the reaction ^{204}Pb(t,p)^{206}Pb at 20 MeV and the reaction ^{208}Pb(p,t)^{206}Pb at 22 MeV. A magnetic spectrograph was used at angles of 20, 35, and 65°, and the results were averaged to decrease the effects of angular variations in the magnitudes of the relative cross sections. Spin-parity assignments were made, and information on configurations was obtained. (D.C.W.)

44716 SOME DECAY PROPERTIES OF ^{251}Fm AND ^{252}Fm. Chwaszczewska, J.; Gavrilov, K. A.; Kusch, W.; Szymczak, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 25B: 331-2(Sept. 18, 1967).

The 410 ± 10 keV γ rays were observed in coincidence with 6.83 ± 0.01 MeV α particles from the decay of ^{251}Fm, Pb to a ^{251}Fm → ^{247}Cf transition energy of 7.24 ± 0.02 MeV. Two α-particle groups were observed in the decay of ^{252}Fm; τ = 23.0 ± 1.3 h. (auth)

44717 SCATTERING OF 16-MeV PROTONS FROM EVEN TIN ISOTOPES. Makofske, W. (Rutgers-The State University, New Brunswick, N. J.); Slagowitz, M.; Savin, W.; Ogata, H.; Kruse, T. H.; Tamura, T. Phys. Lett., 25B: 322-4(Sept. 18, 1967).

The (p,p′) cross sections to the first 2^+ states in even Sn isotopes were observed to decrease systematically with increasing Ar. Using a coupled-channel calculation with a vibrational model, this result is explained as due to the increase of the imaginary potential with increasing Ar. (auth)

44718 SYNTHESIS OF HEAVY NUCLEI AT HIGH DENSITY. Amiet, J. P.; Zeh, H. D. (Univ., Heidelberg). Phys. Lett., 25B: 305-6(Sept. 18, 1967).

A slow neutron capture process at very high density is proposed for the formation of neutron-rich nuclei. It explains the main features of the abundance distribution of this group of nuclei, and may produce U and Th nuclei in by-passing the α-instability region. (auth)

44719 A POSSIBLE DESCRIPTION OF "ROTATION-LIKE EXCITATIONS" IN Te, Xe, AND Ba ISOTOPES. Marumori, T. (Kyushu Univ., Fukuoka); Shono, Y.; Yamamura, M.; Tokunaga, A.; Miyanishi, Y. Phys. Lett., 25B: 249-52(Sept. 4, 1967).

A possible description of rotation-like excitations in "spherical" nuclei is proposed. (auth)

44720 ISOMER SHIFT AND QUADRUPOLE SPLITTING IN ^{191}Ir AND ^{193}Ir. Wagner, F.; Kloeckner, J.; Koerner, H. J.; Schaller, H.; Kienle, P. (Technische Hochschule, Munich). Phys. Lett., 25B: 253-5(Sept. 4, 1967).

Isomer shifts were measured for various γ transitions in ^{191}Ir (82 keV, 129 keV) and ^{193}Ir (keV, 139 keV). Ratios and absolute values of $\delta\langle r^2\rangle$ were deduced. The ratio of the ground-state quadrupole moments was determined to be $Q_{191}/Q_{193} = 1.03 \pm 0.03$. (auth)

44721 OBSERVATION OF THE MOESSBAUER EFFECT IN ^{238}U FOLLOWING COULOMB EXCITATION. Oleson, J. R.; Lee, Y. K.; Walker, J. C.; Wiggins, J. W. (Johns Hopkins Univ., Baltimore, Md.). Phys. Lett., 25B: 258-9(Sept. 4, 1967).

Experiments performed on uranium show that the Mössbauer effect can be observed following Coulomb excitation of an actinide. There is evidence of structure in the observed spectra which may be due to quadrupole hyperfine splitting. (auth)

44722 GROUND STATE SPIN OF ^{129}Te BY POLARIZATION MEASUREMENTS OF PROTONS SCATTERED VIA ANALOGUE RESONANCES. Jolly, R. K.; Maxson, D. R.; Neilson, G. C.; Jones, G. A. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett., 25B: 265-6(Sept. 4, 1967).

Polarization measurements of protons elastically scattered from ^{128}Te were made at bombarding energies spanning the ^{129}Te ground-state isobaric analog resonance at 7.95 MeV. The measurements allow an unambiguous $d_{½}$ assignment for the ground state of ^{129}Te. (auth)

44723 PROTON PARTICLE-HOLE STATES IN ^{116}Sn. Biggerstaff, J. A. (Oak Ridge National Lab., Tenn.); Bingham, C.; Miller, P. D.; Solomon, J.; Seth, K. K. Phys. Lett., 25B: 273-5 (Sept. 4, 1967). (ORNL-P-3208).

The reaction ^{115}In(^{3}He,d)^{116}Sn was studied at 25.6 MeV. It is found that low-lying neutron particle-hole states are extremely weakly excited whereas core excitations consisting of the $g_{9/2}$ proton hole coupled to protons in the $d_{5/2}$, $d_{3/2}$, and $g_{7/2}$ shells are strongly excited. DWBA estimates of the strength of the various "gross structure transitions" are given. (auth)

44724 THE TOTAL NEUTRON CROSS SECTION OF PALLADIUM FROM 0.005 TO 10 eV. Teich, M. C.; Schweitzer, P. J.; Anderson, C. A.; Thompson, T. J. (Massachusetts Inst. of Technology, Cambridge). Nucl. Sci. Eng., 30: 145(Oct. 1967).

The neutron total cross section of Pd was measured in a transmission experiment by the time-of-flight method, using the fast neutron chopper at the MIT reactor. A resonance was found at 2.97 ± 0.06 eV, and its cross section and width were determined to be 14.3 ± 1.6 b and 93 MeV. Between 0.005 and 0.05 eV, the cross section is satisfactorily described by the relation $\sigma = A + BE^{-0.5}$, where E is the neutron energy. (D.C.W.)

44725 DECAY CHARACTERISTICS OF ^{146}Pm. Bunney, L. R.; Scadden, E. M. (Naval Radiological Defence Lab., San Francisco). J. Inorg. Nucl. Chem., 29: 2497-2502(Oct. 1967).

The half-life of ^{146}Pm was determined to be 2020 ± 18 days (5.53 ± 0.05 yr). The ^{146}Pm was produced by a (p,n) reaction on enriched ^{146}Nd. The decay of the purified ^{146}Pm was followed on both β-ray and γ-ray counters. The γ-ray energies were determined from pulse-height distribution curves obtained with a Ge(Li) detector. Prominent γ rays with energies of 453, 736, and 747 keV and low abundance γ rays with energies of 146, 589, 634, and 1189 keV were observed. (auth) (UK)

44726 ALPHA DECAY OF NEUTRON-DEFICIENT FRANCIUM ISOTOPES. Valli, K.; Hyde, E. K.; Treytl, W. (Univ. of California, Berkeley). Contract W-7405-Eng-48. J. Inorg. Nucl. Chem., 29: 2503-14(Oct. 1967). (UCRL-17272).

Isotopes of francium lighter than mass 214 were studied by bombardment of ^{197}Au with ^{16}O and of ^{205}Tl with ^{12}C. Si(Au) surface-barrier detectors were used in on-line measurements to determine α-decay energies and half-lives. Mass number assignments of francium-213-203 were based on excitation functions and on genetic relationship with emanation and astatine isotopes. Isomerism was detected in ^{204}Fr. Results are compared with previous work. (auth) (UK)

44727 YIELDS AND ISOMERIC YIELD RATIOS OF ANTIMONY ISOTOPES FROM THE INTERACTION OF 159-MeV TO 18.2-GeV PROTONS WITH URANIUM. Hagebo, E. (CERN, Geneva). J. Inorg. Nucl. Chem., 29: 2515-32(Oct. 1967).

Relative cross sections were measured for the formation of antimony isotopes of A = 115 to 131 by bombarding uranium with protons of energies from 159 MeV to 18.2 GeV. Absolute cross sections were measured at 570 MeV and 18.2 GeV. The isotopic yield distributions show a broadening towards lower mass numbers when the bombarding energy increases, but also a remaining structure at the highest mass numbers A = 128 to 131. Isomeric yield ratios were also determined at the same energies for the isomeric pairs of antimony at mass numbers 116, 120, 124, and 126. Each of these ratios remains constant throughout the energy range. Qualitative arguments are presented suggesting that structure observed in isotopic yield distributions in the mass region 115 to 140 from high-energy proton bombardments of uranium is due to a combined effect of the breadth of the spectrum of energies deposited in the target nucleus by the protons, and the large and rapid variations in the deformabilities of the nuclei when crossing the 82-neutron shell. The assumption that the fragments are "cold" in the scission configuration seems to be necessary. An attempt to calculate the angular momentum distribution of the primary fragments from knowledge of the isomeric yield ratios leads to a demand for more, and accurate, recoil measurements giving kinetic energies and excitation energies of the fragments. In the course of the work, new determinations of the half-lives of seventeen nuclides from ^{115}Sb to ^{131}Sb were made on isotope-separated samples. (auth) (UK)

44728 CASCADE RELATIONS IN THE DECAY OF ^{131}Ba. Murty, V. Radhakrishna; Jnanananda, S. (Andhra Univ., Waltair, India). Proc. Phys. Soc. (London), 91: 600-4(July 1967).

The cascade relations in the level scheme of ^{131}Cs were studied with a sum coincidence spectrometer. A number of gamma rays, as well as an additional 967 keV transition, were observed. The latter suggests a spin of $5/2^+$ for the 1046-keV level. The new levels at 697 and 585 keV were well established. (auth) (UK)

44729 EXCITED STATES OF THE ^{155}Gd NUCLEUS. Kormicki, J. (Inst. of Nuclear Physics, Krakow); Niewodniczanski, H.; Stachura, Z.; Zuber, K.; Budziak, A. Nucl. Phys., A102: 253-72(1967).

The internal conversion electron spectrum of the decay ^{155}Tb → ^{155}Gd in the energy range 8 to 600 keV was measured with the aid of a semicircular, beta-ray spectrograph. The activity was produced in the spallation of Ta nuclei with 600 MeV protons. The energies and relative intensities of the conversion lines were measured, and for some transitions their multipolarities and mixing ratios were also determined. The obtained experimental data are presented in the decay scheme of ^{155}Tb. The decay scheme is discussed in terms of the Nilsson model by taking into account the Coriolis coupling and the interaction between states differing in oscillator quantum number by $\Delta N = 2$. From the obtained experimental data, the matrix element of the interaction $|\langle[402]5/2^+|\mathcal{H}_\delta|[651]3/2^+\rangle|$ and the Coriolis coupling parameters of the interaction between the states $[651]3/2^+$ and $[642]5/2^+$ and between the states $[660]1/2^+$ and $[651]3/2^+$ were estimated and the values obtained compared with the theoretical predictions. (auth)

44730 THE (0^+)-(0^+) BETA TRANSITION IN ^{156}Eu. Van Neste, L.; Coussement, R.; Deutsch, J. P. (Louvain Univ., Belg.). Nucl. Phys., A102: 369-75(1967).

A measurement of the spectrum shape correction factor of the ground-state to ground-state (0^+)-(0^+) beta transition of ^{156}Eu, with a carefully tested magnetic beta spectrometer, is reported. The analysis is performed using a formalism which accounts for eventual higher order corrections. The uncertainty in the determination of second-forbidden matrix elements from these data is stressed; calculations of the longitudinal polarization show the usefulness of a measurement of this observable for the determination of these matrix elements. The value of the isobaric spin impurity and that of the mixing matrix element is derived. (auth)

44731 A STUDY OF THE SPONTANEOUSLY FISSIONING ISOMER OF ^{242}Am THROUGH THE ^{241}Am(n,γ) REACTION. Flerov, G. N. (Joint Inst. for Nuclear Research, Dubna, USSR); Pleve, A. A.; Polikanov, S. M.; Tretyakova, S. P.; Boca, I.; Sezon, M.; Vilcov, I.; Vilcov, N. Nucl. Phys., A102: 443-8(1967).

The excitation function for the ^{241}Am(n,γ)^{242m}Am reaction leading to the excitation of the 14 ms, spontaneously fissioning isomer has been studied in the range 0 to 6.5 MeV. The experiment results can be well explained taking into account the hypothesis of Strutinsky concerning the "shape isomerism." (auth)

44732 ENERGY OF THE ISOMERIC TRANSITION IN ^{109}Ag. Libert, J. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). Nucl. Phys., A102: 477-80(1967). (In French).

The energy of the gamma ray emitted during the isomeric transition in ^{109}Ag was measured using a Ge(Li) detector. The obtained value (88.05 ± 0.05 keV) is greater than the Pb K electron binding energy, and the PbK x rays were effectively observed. (auth)

Nuclear Theory

Refer also to abstracts 43269, 43614, 44331, 44388, 44424, 44542, 44544, 44562, 44576, 44577, 44586, 44589, 44604, 44606, 44609, 44610, 44654, 44682, 44684, 44707, 44717, and 44719.

44733 (CEA-R-3285) TRAITEMENT DES INFORMATIONS ISSUES D'UN SPECTROMETRE γ. APPLICATION A L'ETUDE DE SCHEMAS DE DESINTEGRATION. (Processing of Data Issued From γ Spectrometer. Application to the Study of Decay Schemes). Boulanger, Jean-Pierre; Legrand, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). July 1967. 42p. (In French). Dep.

A method of generating gamma spectra corresponding to any energy from a library of some basic spectra is discussed, and the application of the technique to the determination of nuclear decay schemes is outlined. The accuracy of the technique is demonstrated by comparing some calculated spectra with spectra obtained using NaI(Tl) and Ge(Li) spectrometers. Some studies of the decay schemes of ^{134}Cs and ^{95}Zr by this technique are summarized. (D.C.W.)

44734 (IN-1098) INVERSION OF THE LEVEL MATRIX IN R-MATRIX THEORY BY THE METHOD OF RANK ANNIHILATION. Watanabe, T. (Idaho Nuclear Corp., Idaho Falls). Aug. 1967. Contract AT(10-1)-1230. 36p. Dep. CFSTI.

The level-matrix approach to the problem of matrix inversion in R-matrix theory still requires inverting the level matrix if the collision matrix is to be used for calculating cross sections. It is shown that the method of rank annihilation inverts the level matrix in analytical form for the general case. The general results are then specialized to the cases of two and three channels, and the expressions for the scattering and fission cross sections are obtained. Although the results of the specialized treatment are applied to the two-level situation, the relevant expressions are in a form that allows a generalization to any number of levels (channels are still restricted to 2 and 3 in number). The approximations, which can be made to simplify the reduced widths and which can eliminate off-diagonal channels as well as the application of these modifications, will be discussed. (auth)

44735 (INP-532/PL) ANALIZA PRZESUNIEC FAZOWYCH DLA ROZPRASZANIA ELASTYCZNEGO CZASTEK NA JADRACH ATOMOWYCH PROGRAM PCS NA MASZYNE ORDA 1003. (Phase Shift Analysis for the Elastic Scattering of Particles on Atomic Nuclei Programme PCS for the ODRA 1003 Computer). Slizynski, A. (Institute of Nuclear Research, Krakow (Poland)). 1967. 40p. (In Polish). Dep.

A program for computing angular distributions for elastic scattering of particles on atomic nuclei for use with the digital computer ODRA 1003 is described. The angular distributions calculated with phase-shifts given in numerical or analytical form could be fitted to experimental angular distributions. (auth)

44736 (JINR-P4-3447) DIFRAKTSIONNOE RASSMOTRENIE REAKTSII SRYVA NA DEFORMIROVANNYKH YADRAKH. (Diffraction Method for Studying Stripping Reaction on Deformed Nuclei). Luk'yanov, V. K.; Petkov, I. Zh. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 27p. (In Russian). Dep.

Stripping and pickup reactions were found to be useful for obtaining information on the properties of deformed nuclei, such as the spectra of the emitted particles and differential cross sections. For direct processes, the distorted-wave method was found to be very useful. In this connection, the contribution of all of the rotational levels of the nuclei to the cross section were considered, studying the stripping process on deformed nuclei, without using

the perturbation theory as a parameter of the deformation. The study involved investigation of the distorted waves within the field of a deformed nucleus. The expression obtained contained, in addition to the usual terms related to one-stage stripping, those of multistage stripping reactions which are of interest for the excitation of reactions at higher rotational levels. The diffraction method allowed one to simplify the expression for the stripping cross section. The angular distributions in such reactions were quantitatively analyzed, using the $^{24}Mg(d,p)^{25}Mg$ reaction as an illustration for the comparison of theoretical and experimental results. (TTT)

44737 (UCB-34P20-OR4) DYNAMIC ORIENTATION OF NUCLEI. Jeffries, C. D. (California Univ., Berkeley, Dept. of Physics). [1966]. Contract AT(11-1)-34. 27p. (CONF-670812-7). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

A review is given of some methods for orienting nuclei in matter which are distinctly nonthermal equilibrium in nature and are based on the preferential population of nuclear magnetic states by irradiation at some resonance frequency of the system. Microwave dynamic nuclear orientation and nuclear spin cooling are the two broad categories of techniques covered. (D.C.W.)

44738 (UCRL-17729) NUCLEAR MOMENTS. Sorensen, R. A. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 23p. (CONF-670812-14). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

Some recent developments in techniques for measuring nuclear moments and in the nuclear structure theory of nuclear moments are discussed. (D.C.W.)

44739 (ZFK-122, pp 9-19) NEW APPROACH TO THE OLD CLASSIFICATION PROBLEM OF NUCLEAR STATES. Szpikowski, S. (Manchester Univ. (England). Marie Curie Sklodowska Univ., Lublin (Poland)).

A discussion is given on the classification of nuclear states using group theory. The group R_3 is introduced with the resulting classification in L-S coupling, which is the same as that of the R_3 group in j-j coupling. (S.F.L.)

44740 (ZFK-122, pp 20-7) SU_3 DESCRIPTION OF THE NUCLEAR STATES. Doenau, F. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The collective characteristics of levels in light nuclei, which are indicated by the rotational structure of the spectra and enhanced E2 transitions, are described by the SU_3 model. A connection is thereby given between the shell model and the collective model. (S.F.L.)

44741 (ZFK-122, pp 28-50) ON THE FOUNDATIONS OF THE THEORY OF NUCLEAR REACTIONS. Rosenfeld, L. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)).

An account is given of the theory of nuclear reactions using a treatment based on the asymptotic behavior of the wave functions. The introduction of channel radii and boundary conditions is entirely avoided. The discussion of the analytic properties of the S-matrix is systematically referred to the energy plane, rather than to the plane of the complex wave number of some selected channel; however, cases in which direct consideration of the wave numbers is preferable are discussed. (S.F.L.)

44742 (ZFK-122, pp 51-5) SHELL-MODEL THEORY OF COMPOUND NUCLEUS REACTIONS. Weidenmueller, H. A. (Heidelberg Univ. (West Germany). Institut fuer Theoretische Physik).

The basic physical ideas involved in the shell-model theory of compound nuclear reactions are summarized, avoiding the use of formal procedures. The shell-model approach consists in the attempt to expand the complete wave function of the system (scattered particle plus target) into a complete set of linearly independent, properly antisymmetrized shell-model wave functions. It is restricted to reactions in which no more than two fragments are produced, and is further restricted by the center-of-mass problem of shell theory which may introduce spurious states into the calculation. The complete set of shell-model states is truncated and thereby an approximation is made which should be good for low-energy reactions. (S.F.L.)

44743 (ZFK-122, pp 57-70) CONFIGURATION MIXING DESCRIPTION OF CONTINUUM STATES. Gillet, V. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

The existence, within a good approximation, of an average nuclear field suggests the separation of the complete Hamiltonian into two parts $H = H_0 + V$ where the shell model Hamiltonian H_0 defines a complete set of orthonormal vectors $|\alpha\rangle$ representing nucleons moving independently in a potential well, and V is the residual interaction between nucleons which remains after extracting the average potential. The solutions Ψ_E of the total Hamiltonian H for bound states ($E < 0$) is expanded in terms of the bases $|\alpha\rangle$, $\Psi = \Sigma_\alpha a_\alpha|\alpha\rangle$, with the configuration mixing coefficients a_α being given by an eigenvalue problem. The extension of this formalism to unbound states ($E < 0$) is considered. (S.F.L.)

44744 (ZFK-122, pp 119-25) TRITON BINDING ENERGY AND THE NEUTRON-DEUTERON SCATTERING LENGTHS. Sitenko, A. G.; Kharchenko, V. F.; Petrov, N. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Fiziki).

The effect of the shape of the two-nucleon interaction on values of the quartet and doublet neutron-deuteron scattering lengths and binding energy of tritons was studied. The interaction between nucleons is described by a nonlocal separable potential. (S.F.L.)

44745 (ZFK-122, pp 143-5) SHELL-MODEL DESCRIPTION OF DIRECT NUCLEAR REACTIONS. Weidenmueller, H. A.; Dietrich, K. (Heidelberg Univ. (West Germany). Institut fuer Theoretische Physik).

The shell model description of nucleon scattering by a target nucleus presented by Weidenmüller is generalized by including direct reactions and by considering reactions involving bound projectiles. (S.F.L.)

44746 (ZFK-122, pp 146-8) EXACT DESCRIPTION OF ELASTIC SCATTERING PROCESSES AND DEDUCTION OF THE OPTICAL NUCLEAR MODEL. Elk, K. (Technische Universitaet, Dresden (East Germany). Institut fuer Theoretische Physik).

The scattering of a single particle by a bound system of particles is considered. This is a real many body problem with the interaction V among all particles. For elastic scattering the problem is reduced to a one body problem, thus to a potential scattering. (S.F.L.)

44747 (ZFK-122, pp 183-8) ORIENTATION EFFECTS IN $1_n = 1$ DEUTERON STRIPPING REACTIONS. Barz, H. W.; Hehl, K.; Riedel, C.; Slotta, J. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The influence of the spin-orbit coupling term in the explanation of the measured values of the correlation function spin-dependent terms in the optical potential is discussed. The results are applied to the $^{12}C(d,p)^{13}C$ stripping reaction. (S.F.L.)

44748 (ZFK-122, pp 189-93) ANGULAR CORRELATION SYMMETRY OF THE γ RAYS FOLLOWING THE STRIPPING AND KNOCK-OUT REACTION IN THE FINITE RANGE APPROXIMATION. Cejpek, J. (Brno Univ. (Czechoslovakia)).

The result that the symmetry axis of the correlation function for the γ-rays which are detected in coincidence with the outgoing particle in the knock-out process is the same as in the direct stripping reaction is shown to be changed if the finite range of nuclear forces is taken into account. In the plane-wave approximation this does not cause any difficulties in the direct stripping as well as in the heavy particle stripping, but for the knockout process a special model must be chosen in order to obtain an analytically calculable case. (S.F.L.)

44749 (ZFK-122, pp 270-4) RESONANCE SCATTERING FORMULATED BY MEANS OF THE PERTURBATION SERIES FOR THE ONE-PARTICLE GREEN FUNCTION. Pfitzner, A. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

An expression for the scattering amplitude in the simple case of pure elastic scattering is derived by a method which avoids projection operators and which can be connected in a very illustrative way to realize what happens if a nucleon enters a nucleus. To obtain a mathematical equivalent of this picture, the perturbation graphs of the one particle Green function are used. (S.F.L.)

44750 (ZFK-122, pp 244-8) ANALYSIS OF THE CLUSTER STRUCTURE OF LIGHT NUCLEI WITH LITHIUM IONS. Rotter, I. (Joint Inst. for Nuclear Research, Dubna (USSR).

The lithium nuclei are considered as a more or less weak association of two clusters, as $\alpha + d$ or $\alpha + t$. This model is used to study Li-induced reactions, using Butler theory for (d,p) stripping reactions. Some characteristic differences between deuteron- and Li-induced reactions are considered. It is shown that the theory of plane waves (without accounting for Coulomb interaction) can be used to explain some typical results of Li-induced reactions. (S.F.L.)

44751 (ZFK-122, pp 337-42) PAIRING CORRELATIONS IN DOUBLE MAGIC NUCLEI. Jaeger, H. U.; Muenchow, L. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

The role of the pairing effect in explaining the position of the first excited 0^+ state in double magic nuclei like ^{16}O is shown by using a simple model. (S.F.L.)

44752 (ZFK–122, pp 343-8) GENERALIZED NOGAMI METHOD FOR PROTON–NEUTRON CORRELATIONS. Kissener, H. R.; Muenchow, L. (Zentralinstitut fuer Kernforschung, Rossendorf bei Dresden (East Germany)).

A system of nucleons in an average spherical field with a charge-independent residual pairing interaction effective only in two-particle states with total angular momentum I = 0 and isospin T = 1, is considered. The Nogami method is applied to this system in an investigation of the problem of neutron-proton pairing in light nuclei. (S.F.L.)

44753 (ZFK–122, pp 349-52) CORRECTION OF THE CRANKING MODEL BY MEANS OF PERTURBATION THEORY. Lehmann, G. (Technische Universitaet, Dresden (East Germany). Institut fuer Theoretische Physik).

It is shown that it is possible to describe collective rotational nuclear states by means of the cranking model with external potential by computation of all orders in ω (the angular velocity) in the perturbation series, whereas it is impossible in the case without external potential. (S.F.L.)

44754 NONPERTURBATIVE CALCULATION OF NUCLEAR MATRIX ELEMENTS FROM TWO-NUCLEON PHASE SHIFTS. Koltun, D. S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 910-13(Oct. 16, 1967).

A method is presented for calculating two-body shell-model interaction matrix elements from scattering phase shifts, which applies to shifts of any magnitude and to tensor coupling. It is assumed that the average (shell-model) potential, expressed in two-nucleon relative coordinates, is slowly varying within the range of the free two-nucleon interaction. Examples are given for the p shell and are compared with the results of other methods, some of which include Pauli corrections. (auth)

44755 EXPERIMENTAL DETERMINATION OF NUCLEAR COMPRESSIBILITY ON THE BASIS OF THE ISOTOPIC SHIFTS OF X-RAY LINES. Mezentsev, A. F.; Smirnov, Yu. P.; Sumbaev, O. I.; Marushenko, V. I.; Egorov, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1167-72(July 1966). (In Russian).

The compressibility of nuclear matter was determined by a method similar to that based on the isotopic shift (IS) of optical lines, using the IS of x-ray lines. Assuming that the nuclear matter possesses a finite compressibility, the nuclear density depends on the ratio of neutrons and protons. The addition of neutrons to the nucleus results in a decrease of the nuclear density because the Coulomb energy is decreased. Such an increase of the radius caused by the addition of only neutrons may be observed by determining the IS. The experiments involve the measurement of the IS of the K levels of 4 pairs of isotopes: $^{144}Nd-^{148}Nd$; $^{144}Nd-^{150}Nd$; $^{144}Sm-^{150}Sm$; and $^{144}Sm-^{152}Sm$, and by using the authors' earlier studies on similar shifts of the $^{235}U-^{238}U$; $^{92}Mo-^{100}Mo$ and $^{94}Mo-^{100}Mo$ pairs. The compounds NdF_3 and SmF_3 were used in the experiments. The IS values obtained were brought into agreement with the averaged experimental data obtained with stable nuclei by electron scattering without making assumptions concerning the compressibility. In view of the fact that the shell effects have not been considered, no generally valid conclusions may yet be drawn from the data; it must be also kept in mind that the theory relates to an infinite nuclear matter, while the experimental data are based on finite matter. (TTT)

44756 DESCRIPTION OF ELASTIC SCATTERING OF NEUTRONS ON NUCLEI BY MEANS OF THE NONLOCAL OPTICAL POTENTIAL. Dotsenko, B. B.; Strizhak, V. I. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1107-13(July 1966). (In Russian).

The customary form of the virtual portion of the local optical potential used to describe the scattering of neutrons and other particles on nuclei resembles the density distribution function of nucleonic matter in the nucleus correlating the atomic weight and the diffusivity of the surface layer. However, the optical potential is generally not localized. The local potential parameters depend on the energy of the incident particles while the nonlocal parameters do not. A nonlocal optical potential was therefore considered. The derivations obtained yield a precise analytic solution for the Schroedinger equation for the lth partial wave of the scattered particle. The form of the imaginary portion may be determined from the parameters of the virtual portion. For each given nucleus, three, or at most four, parameters must be obtained, this is achieved by dividing the parameters into "geometric" ones, such as radius and larger diffusivity, related to the structure of the nucleus, and "dynamic" ones, which determine the interaction with the incident particles. It is thus possible to determine the parameters of the interaction of neutrons with the scattering nuclei. Results of these calculations for average-heavy nuclei will be published soon. (TTT)

44757 EQUILIBRIUM DEFORMATION OF HEAVY NUCLEI. Bal'butsev, E. B.; Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1118-23(July 1966). (In Russian).

The experimental functions concerning the equilibrium deformation of nuclei which approximates the ground state function do not exhibit rotational symmetry. Such studies are especially useful for examining the deformation of heavy nuclei in which it is difficult to derive functions with a fixed angular momentum. On the basis of an approximation of the function, estimates were made concerning the reestablishment of the rotational symmetry of the wave functions which could change the theoretical predictions on the equilibrium deformation of nuclei and of the formation and depth of the energy minimum. In order to obtain the required approximate expressions, the function approximating the wave function of the nucleus is analyzed on the basis of the exact eigenfunctions of the system, assuming that the Hamiltonian of the system is known. The formula obtained without considering the pair correlations is not precise for small values of the deformation parameter δ; the corrections give only an order of magnitude of the effect. In all the examples used, the approximate calculations of the symmetry function indicate the appearance of a γ deformation with a barrier up to 0.43 MeV (^{184}Os) and the increase of the value of δ corresponding to equilibrium deformation. (TTT)

44758 VERTEX PARTS AND THE OVERLAP INTEGRALS IN THE THEORY OF DIRECT NUCLEAR REACTIONS. Blokhintsev, L. D.; Dolinskii, E. I.; Turovtsev, V. V. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 49-57(Jan.-Feb. 1967). (In Russian).

The relationship between matrix elements in direct nuclear reactions in an ordinary formulation using wave functions and in diagram concept was analyzed. It is shown that with certain selection of the open points on the diagram the Born matrix elements for stripping, elastic scattering and double transmission coincide with the amplitude matrix elements on corresponding Feynman diagrams. The problem of apex point selections in the diagram concept is discussed. (R.V.J.)

44759 DISCRETE STATIONARY STATES IN THE HIGH SECTORS OF THE LEE MODEL. Gostev, V. B. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 3-10(Jan.-Feb. 1967). (In Russian).

A method of consequent replacement of nuclear by a decayed nucleons was used for approximate solution of the integral equations for wave functions of the discrete stationary states of high single-fermion sectors in a Lee model. The bond between the energy levels and the interaction constant was found. It is shown that in each sector there is only one discrete state which with the expanded constant of interactions strives to finite limits. The discrete state energy levels in various sectors are equidistant in the case of strong bonds. (tr-auth)

44760 MEASUREMENT OF THE ABSOLUTE YIELDS OF NUCLEAR REACTIONS BY ACTIVATING SAMPLES IN THE BREMSSTRAHLUNG BEAM. Baciu, G.; Catana, D.; Deberth, C.; Raileanu, I. Stud. Cercet. Fiz., 19: 541-60(1967). (In Rumanian).

A photonuclear reaction is characterized by its yield, the energy distribution, and the angular distribution of the photoproducts. Measurement of the number of pulses within a given time interval allows one to determine the yield, cross section, and angular distribution. The bremsstrahlung spectrum is identified by the energy distribution function of the photons and the distribution function of their number. The radiation, Q, may be directly evaluated only by calorimetric measurements; proportional indication may be obtained by means of ionization chambers. Irradiation-induced accumulation of active photonuclides generated by a nuclear reaction depends on the number of nuclei activated per mole in a unit time and the number of nuclei disintegrating during the same period. Thus, in order to determine the yield, the activity of a sample at the end of the irradiation must be measured, determining the radiation by integrating the ionization current. Knowledge of the absolute yields makes it possible to compare data obtained in different laboratories, eliminating the uncertainty due to differences in the geometry. (TTT)

44761 EXTENDED TWO-PARTICLE SHELL MODEL IN LIGHT NUCLEI. Evans, J. A.; Perazzo, R. P. J. (Fundacion Bariloche, Buenos Aires). Nucl. Phys., A103: 225-37(1967).

The validity of the ladder approximation as applied to the two-particle shell model is discussed in terms of soluble two-level model. A modified approximation is proposed which gives superior

results for the energy spectra and the spectroscopic factors for two-particle transfer reactions. (auth)

44762 POLARIZATION OF NUCLEI BY INTERACTION WITH ELECTRON SHELLS. Djrbashian, V. A. (Univ. of Copenhagen). Nucl. Phys., A103: 177-87(1967).

Polarization of nuclei by hfs coupling is discussed in cases when polarized electrons are captured in Bohr orbits in the absence of an external field and when the atom is in an external static magnetic field (Gorter-Rose method). In the latter case, the expression for the polarization is deduced when the hfs coupling is strong, and the straightforward calculation of the second-order term is performed when the hfs coupling is weak. (auth)

44763 A NEGATIVE-PARITY ASYMMETRIC MODEL FOR ^{228}Th. Davidson, M. G. (Australian National Univ., Canberra). Nucl. Phys., A103: 153-64(1967).

A collective asymmetric-rotor model is developed for negative-parity levels in deformed even nuclei and is applied to ^{228}Th. The work is based on the asymmetric-rotor model for positive-parity states of Davydov and Chaban and assumes the deformed shape for negative-parity states to be mostly quadrupole with some additional octupole deformation. Energy-level schemes are obtained, electric quadrupole transitions are discussed, and the results are compared to earlier models. (auth)

44764 COMPLEX SYMMETRY TERM IN THE NUCLEON OPTICAL POTENTIAL. Hodgson, P. E. (Nuclear Physics Labs., Oxford). Nucl. Phys., A103: 127-33(1967).

Neutron data at 25 and 96 MeV are analyzed to determine the dependence of the absorbing potential on the nuclear symmetry parameter. The results depend on the form factors chosen for the imaginary potentials; and since these are not determined by the data, it is impossible to establish the presence of a complex symmetry term. (auth)

44765 STATE DEPENDENCE OF SHELL-MODEL REACTION MATRIX ELEMENTS. Kuo, T. T. S. (Princeton Univ., N. J.). Contract AT(30-1)-937. Nucl. Phys., A103: 71-96 (1967). (PUC-937-255).

Shell-model reaction matrix elements are calculated with a combination of the Moszkowski-Scott separation method and the reference-spectrum method of Bethe, Brandow and Petschek. The reaction matrix G is expanded in terms of G_s and V_L, where G_s is the reaction matrix for the short-range potential V_s and V_L the long-range potential. The contribution from G_s is then calculated with the reference-spectrum method, where the main criterion for choosing the separation distance is that G_s is best approximated by G_s^R, the reference-spectrum approximation of G_s. The second-order tensor term V_{TL} $(Q/e)V_{TL}$ is calculated with the closure approximation of Kuo and Brown, however the effective energy denominator is now state-dependent, which means that it has a dependence on binding energy, the local density and the center-of-mass quantum number. The contributions from V_{TL} $(Q/e)V_{TL}$ vary almost linearly with $\rho^{\frac{1}{3}}$, where ρ is the local density. The reaction matrix elements so calculated have a fairly strong state-dependence which comes in predominantly through G_s and V_{TL} $(Q/e)V_{TL}$. The state dependence can be approximated quite accurately in a simple way, and thus the application to finite nuclei is convenient. Shell-model applications have been made for nuclei ^{18}O and ^{18}F and we find that the matrix elements are generally weaker than those of Kuo and Brown, especially for those of $T = 1$, $J = 0^+$ and $T = 0$, $J = 1^+$. This is desirable, because the Kuo and Brown matrix elements are often somewhat too strong. (auth)

44766 NUCLEAR FISSION. 3. EXPLANATION OF UNSYMMETRICAL FISSIONS BY THE STATISTICAL TREATMENT, AND SUMMARY. Honda, Takao (Yamanashi Univ., Kofu, Japan). Yamanashi Daigaku Gakugeigakubu Kenkyu Hokoku, No. 16, 111-15(Feb. 1966). (In Japanese).

By the statistical treatment, proposed by Fong et al., it has been found that the following, which are most characteristic for nuclear fissions, can be adequately explained: the saw-toothed dependence of prompt-neutron emission on the fragment mass; a remarkable decrease in the total kinetic energy of fission fragments in the unsymmetric-fission groups; and the predominance of unsymmetric fissions in low-energy nuclear fissions. The symmetric nuclear fission, widely accepted at the present, applies only to its fragment masses, and the state (or condition) of each fragment is not symmetric with the other. In scission of a nucleus, the deformation of each fragment is difficult in the vicinity of its closed shell, as in ordinary nuclei, and the closed shell of $N = 50$ and $Z = 50$ is the most important in explaining the above facts. (NSA of Japan)

44767 INFLUENCE OF THE FINITE DIMENSIONS OF A NUCLEUS WITH MAGNETIC MOMENT ON THE BREMSSTRAHLUNG OF POLARIZED ELECTRONS. Kerimov, B. K.; El Khabiri, Kh. A. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1387-95(Aug. 1966). (In Russian).

In previous studies of polarization effects in the bremsstrahlung of polarized electrons in the Coulomb field of surface and point sources the magnetic moment of the nucleus was not taken into account. For this reason, the differential cross section of the bremsstrahlung of both polarized and nonpolarized electrons in the field of a nucleus possessing a magnetic dipole moment was investigated as function of the charge and magnetic moment distribution, using the Born approximation. The generalized formulas derived revealed the effect of the final dimensions and of the magnetic dipole moment of the nucleus on the angular and energy distribution of the radiation from nonpolarized electrons and on the level of circular polarization of the bremsstrahlung photons, emitted longitudinally by the polarized electrons. The backward bremsstrahlung was also studied, in order to determine the effects due to the nuclear magnetic moment and the structure of the nucleus. The magnetic moment of the target nuclei is indicated in the angular distribution of photons emitted at angles close to 180°. The calculations are illustrated by graphs concerning ^{7}Li, ^{9}Be nuclei and protons. The final dimensions of a nucleus with a magnetic dipole moment were found to affect strongly the bremsstrahlung electrons at large angles and energies. (TTT)

44768 CALCULATIONS OF TRANSITION INTENSITIES IN DEFORMED NUCLEI CONSIDERING THE IMPURITIES ACCORDING TO THE QUANTUM K NUMBER. Mikhailov, V. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1334-9(Aug. 1966). (In Russian).

The relation between the collective and internal motions in deformed nuclei determines the nonconservation of the projection of the angular momentum on the symmetry axis of the nucleus. The wave function of the rotational state may be represented as the superposition of states with various values of the projection of the momentum (K); the function may be derived by perturbation theory. In order to obtain the angular dependence of the amplitude, it must be assumed that the Hamiltonian arbitrary angular momentum operators, multiplied by certain operators, act on internal variables. Each state in the deformed nuclei may be characterized by a value of K. It is assumed that the amplitudes due to additives decrease in proportion of the deviation of the corresponding value of K_{add} from the primary value of K. The $\Delta K < 1$ γ transition probability is also considered in the determination of transition schemes. (TTT)

44769 OPTICAL POTENTIAL OF COMPOUND NUCLEI. Kadmenskii, S. G. (Voronezh State Univ., USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1349-56(Aug. 1966). (In Russian).

It was found recently that complex nucleons may not be identified on the basis of the optical model, even though this was assumed before on the basis of scattering data. It was therefore attempted to correlate the optical potentials of complex nuclei with the single-nucleon optical potentials by means of Green's functions. The elastic scattering of deuterons was first examined, generalizing the findings to the scattering of any arbitrarily chosen complex nucleus. As the potential acts not only on the coordinates of the center of gravity of the deuteron but also on its internal coordinates, the wave function relates also to the unbound state of the proton and neutron; however, this may be neglected. It was found that the method based on the application of Green's function allows the prediction of not only the optical potentials of the lightest nuclei but yields information also on interactions within heavy nuclei. (TTT)

44770 POLARIZATION OF PROTONS IN STRIPPING REACTIONS ON HEAVY NUCLEI. Ippolitov, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1367-70(Aug. 1966). (In Russian).

There is considerable interest directed at present to Coulomb stripping reactions involving nuclei with high Z at deuteron energies much below the Coulomb barrier. The fact that the original and ultimate reaction products are not within the range of action of nuclear forces simplifies the problem. It was shown that this method is suited to the study of the Mott–Schwinger spin orbital interaction in the stripping reaction, allowing one to derive a formula for the polarization of protons in the exit channel when the orbital moment of the captured neutron $l_n = 0$. The maximum of polarization lies in the range of the largest change of amplitude of the $A(\theta)$ reaction; i.e., at $\theta = 70$ to 80° in the case of Coulomb stripping. Therefore, it is reasonable to expect that the magnetic polarization of nucleons will be observed more easily in this process than in elastic scattering. (TTT)

44771 PASSAGE OF THE OVERHAUSER EFFECT TO THE SOLID EFFECT IN DYNAMIC NUCLEAR POLARIZATION. Papon, Pierre (Faculte des Sciences, Paris). Compt. Rend., Ser. A and B, 264: 1472-5(May 22, 1967). (In French).

A method for the study of the evolution of the average values of the spin operators of a system of nuclear and electron spins in interaction in a magnetic field was presented in its broad principles. The behavior of the dynamic nuclear polarization in viscous media was deduced. (tr-auth)

44772 SPIN–ORBIT EFFECTS IN THE OPTICAL MODEL ANALYSIS OF DEUTERON AND PROTON ELASTIC SCATTERING. El-Nadi, M.; Zohni, O. (Atomic Energy Establishment, Cairo. Cairo Univ.). Z. Phys., 206: 150-62(1967).

Spin-orbit effects on the differential cross sections for the deuteron and proton elastic scattering are considered. Relations between the parameters of the optical potentials of the deuteron and its constituent nucleons are discussed. The variation of the deuteron and proton potential depths with energy is also considered. (auth)

44773 INVESTIGATION OF TWO-HOLE STATES IN LIGHT NUCLEI. Jackson, D. F. (Univ. of Surrey, London). Nuovo Cim. (10), 51B: 49-65(Sept. 11, 1967).

The structure and properties of the overlap integral for the excitation of two-hole states in light nuclei are discussed, and a formalism is presented by which these overlap integrals are obtained as the solutions of a set of coupled equations. It is shown that the overlap integrals constructed on the basis of simple shell model or cluster model ideas, and used in many calculations on such reactions as (p,pd), (γ,np) and (π^-,2n), do not possess the required properties. (auth)

44774 ABSOLUTE ft VALUES FOR FIRST-FORBIDDEN β TRANSITIONS TO THE COLLECTIVE, NONROTATIONAL STATES OF THE TYPE $J^\pi K = 2 + 2$. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR. International Atomic Energy Agency, Trieste, Italy); Bogdan, D.; Salageanu, S.; Deciu, N. Nuovo Cim. (10), 51B: 66-70(Sept. 11, 1967).

The absolute ft-values for some first-forbidden β-transitions to the collective γ-vibrational states have been calculated. Using the Kotani-Ross formalism it was found that the disagreement between experimental and theoretical ft-values is nearly the same as for the transitions to the one- or two-quasiparticle states. (auth)

44775 GROUND-STATE CORRELATIONS IN SPHERICAL SUPERCONDUCTOR NUCLEI. Savoia, M. (Univ., Bologna. Istituto Nazionale di Fisica Nucleare, Bologna). Nuovo Cim. (10), 51B: 226-9(Sept. 11, 1967).

A study is made of the correlations introduced in the ground state of a spherical "superconductor" nucleus by the residual interaction between quasi-particles. The problem is important because of recent theories which have been proposed to generalize the Tamm-Dancoff and random-phase approximation in order to study the lone-lying vibrational states of medium-heavy spherical nuclei with either proton or neutron closed shells. (S.F.L.)

44776 DETERMINATION OF PHOTONUCLEAR CROSS SECTION BY THE METHODS OF MATHEMATICAL STATISTICS. Ivanchenko, V. G. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 6: 421-5(Aug. 1967). (In Russian).

The widespread methods for calculation of photonuclear cross sections are estimated. A new calculation method based on mathematical statistics is presented. The scheme of analysis may be applied to any experimental matter that deals with solving of the first kind Fredholm equation. (auth)

44777 INDUCED CAPTURE OF ORBITAL ELECTRON. Mikaelyan, L. A.; Tsinoev, B. G.; Borovoi, A. A. Yadern. Fiz., 6: 349-52(Aug. 1967). (In Russian).

The resonance capture of the orbital electron induced by the electron antineutrino is considered. For the allowed transitions the expression is obtained for the cross section averaged over the reactor $\bar{\nu}_e$ spectrum. For heavy nuclei the cross section of the process exceeds the cross section of the "usual" inverse β decay $\bar{\nu}_e + A_z \rightarrow A_{z-1} + e^+$. (auth)

44778 QUASICLASSICAL CALCULATION OF THE EFFECTIVE QUADRUPOLE CHARGE AND OF THE QUADRUPOLE–QUADRUPOLE INTERACTION CONSTANT. Krainov, V. P.; Malov, V. V. Yadern. Fiz., 6: 252-5(Aug. 1967). (In Russian).

It is shown within the framework of the theory of finite Fermi systems that the interaction through core in quadrupole oscillations is of a quadrupole type. The quadrupole force constant is evaluated in terms of the universal constants of the theory of finite Fermi systems and effective quadrupole charge for the protons and neutrons. The results obtained are in agreement with the experimental data on the quadrupole moments and quadrupole transition probabilities for nuclei with one nucleon (nucleon hole) above the closed shell. (auth)

44779 EFFECTIVE FIELD EQUATION IN A FINITE SYSTEM. Sapershtein, E. E.; Khodel', V. A. Yadern. Fiz., 6: 256-64(Aug. 1967). (In Russian).

The effective field equation for a finite system is discussed in the case when the external field wave length is of the order of the system size. The variation of a quasi-particle momentum due to its reflection from the boundary of the system sometimes leads to the effective field components with large momentum transfer (of the order of Fermi momentum p_F). In this case the effective field is not given by zero-angle amplitude. A general relation containing a number of supplementary terms as compared to the relation for the vacuum scattering amplitude was obtained for the quasi-particle scattering amplitude in matter at arbitrary angles. The momentum nonconservation due to the reflection of a quasi-particle from the boundary is shown to be especially important for the cases when the effective field is determined by a small number of transitions, e.g., for calculations of the magnetic moment and allowed beta transitions. (auth)

44780 SPIN–ORBIT CORRECTION TO THE MAGNETIC MOMENT OF A NUCLEUS. Pik-Pichak, G. A. Yadern. Fiz., 6: 265-9(Aug. 1967). (In Russian).

The corrections to the magnetic moment of an odd nucleon due to the two-particle spin–orbit interaction in a nucleus were obtained within the framework of perturbation theory. (auth)

44781 TENSOR FORCES IN THE RESIDUAL INTERACTION BETWEEN PARTICLES IN NUCLEI. Baktybaev, K. B.; Band, I. M.; Sliv, L. A.; Kharitonov, Yu. I. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 270-8(Aug. 1967). (In Russian).

The matrix elements for the tensor forces of the residual pairing interaction are studied in their dependence on the total spin J and on the number of interacting nucleons. The parameters of these forces are obtained from the spectra of the nuclei ^{210}Bi and ^{206}Tl. For heavy nuclei the best agreement with experiment is obtained for the residual interaction $V_p = -(24 - 10\pi_s + 4S_{12}) \exp\{-r_{12}^2/4\}$. The existence of the level 1^- close to ^{206}Tl ground state is discussed. (auth)

44782 METHOD OF APPROXIMATE SEPARATION OF VARIABLES IN THE PROBLEM OF DIFFRACTION SCATTERING OF PARTICLES BY NUCLEI. Inopin, E. V.; Shebeko, A. V. Yadern. Fiz., 6: 279-87(Aug. 1967). (In Russian).

An approximate method for solving the problem of diffraction scattering of particles is discussed. Refined formulae for the diffraction scattering amplitudes and cross sections are obtained. (S.F.L.)

44783 DIFFRACTION THEORY OF SCATTERING OF HEAVY IONS WITH ACCOUNT FOR THEIR MUTUAL EXCITATION. Abul-Magd, A. Ya. (Atomic Energy Commission, Cairo). Yadern. Fiz., 6: 288-92(Aug. 1967). (In Russian).

Elastic and inelastic scattering and mutual excitation of heavy ions having collective excited states are considered in the framework of the adiabatic approximation. A generalized amplitude for these transitions is obtained in terms of the parameters of the scattering matrix and the collective parameters of the colliding nuclei. When the deviation of the nuclear surfaces from sphericity is small, simple expressions are derived for cross-sections of the three above mentioned processes, which are expressed in terms of the same set of parameters. These expressions are in satisfactory agreement with experimental cross-sections of the yields of the collision between ^{12}C and ^{16}O ions. (auth)

44784 OPTICAL MODEL FOR NUCLEONS. Aver'yanov, I. K.; Purtseladze, Z. Z. Yadern. Fiz., 6: 293-8(Aug. 1967). (In Russian).

Analysis of available experimental data on interactions of nucleons having energies up to 100 MeV with nuclei is carried out on basis of the optical nuclear model with surface absorption. The dependence is obtained of optical potential parameters on the energy of incident nucleons as well as on the atomic weight and symmetry coefficient of the nucleus. The optical model for protons is found to differ from that for neutrons with isotopic effect taken into account by presence of the Coulomb correction to the real potential and by the diffusion of the imaginary potential at those nucleon energies when the surface absorption is essential only. The last can indicate the possible existence of extra neutrons on the nuclear surface. (auth)

44785 MECHANISM OF INTERACTION OF HIGH ENERGY PARTICLES WITH COMPLEX NUCLEI. Grashin, A. F.; Shalamov, Ya. Ya. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 6: 299-305(Aug. 1967). (In Russian).

It is shown that in the interaction of high energy particles with

complex nuclei an important role may be played by the mechanism of the peripheral collision between the incident particle a and a relatively light virtual cluster v of the target A (the pole graph). In this act a considerable energy is transferred and a negligible momentum is exchanged between the peripheral and the nonperipheral blocks $a + v \rightarrow b$, $A \rightarrow v + B^*$. The decay of the strongly excited recoil nucleus B^* gives the main part of the heavy fragments emitted at the collision. Some semiphenomenological formulae for the $A \rightarrow v + B^*$ form-factor are found in good agreement with the experiment. The new experimental data on the $A(\pi^+,2p)B^*$ reaction on the nuclei of a freon mixture are presented at the π^+ energy $E_0 = 60 \pm 20$ MeV. (auth)

44786 LOWERING AND RAISING OPERATORS FOR THE ORTHOGONAL GROUP IN THE CHAIN $O(n) \supset O(n-1) \supset \ldots$, AND THEIR GRAPHS. Pang, Sing Chin; Hecht, K. T. (Univ. of Michigan, Ann Arbor). Contract NONR 1224(59). J. Math. Phys. (N. Y.), 8: 1233-51(June 1967).

Normalized lowering and raising operators are constructed for the orthogonal group in the canonical group chain $O(n) \supset O(n-1) \supset \ldots \supset O(2)$ with the aid of graphs which simplify their construction. By successive application of such lowering operators for $O(n)$, $O(n-1)$, ... on the highest weight states for each step of the chain, an explicit construction is given for the normalized basis vectors. To illustrate the usefulness of the construction, a derivation is given of the Gel'fand–Zetlin matrix elements of the infinitesimal generators of $O(n)$. (auth)

44787 ANOMALOUS LEVEL ORDER IN ^{22}Ne: SOLUTION BY MEANS OF TWO CONCURRENT EFFECTS. Abulaffio, Carla (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., 161: 925-8(Sept. 20, 1967).

The experimental order of the ^{22}Ne levels is reproduced by increasing the amount of Majorana exchange as well as the ratio b/a between the harmonic-oscillator length parameter and the range of the residual interaction. Better agreement with experiment is also obtained for the lowest ^{20}Ne band. (auth)

44788 THREE-BODY PROBLEM WITH CHARGED PARTICLES. Noble, J. V. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 161: 945-55(Sept. 20, 1967).

The formal modification, by long-range potentials, of the scattering equations describing three particles interacting through short-range potentials is discussed in terms of the exact Coulomb Green's function, whose mathematical properties are known. This Green's function can be explicitly written down in several special cases; approximate forms of the modified theory are described for these instances. The application of the Coulomb-modified three-particle scattering theory to the α-cluster model of ^{12}C and to deuteron-induced nuclear reactions is described in some detail. For the three-α model, an heuristic generalization of the local plane-wave approximation is used to obtain a simple approximate form for the Coulomb Green's function. This new theory may have some relevance to the problem of helium burning in stars. Finally, in the Appendix a discussion is given of why the methods of multiparticle collision theory fail in the problem of calculating the general three-body Coulomb Green's function at positive, real energies. A possibly useful, mathematically well-defined method for constructing this Green's function at negative real energies is also given. (auth)

44789 SOLUTION OF AND STANDARD APPROXIMATIONS FOR AN EXACTLY SOLUBLE THREE-PARTICLE MODEL OF STRIPPING. Reiner, A. S.; Jaffe, A. I. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 161: 935-44(Sept. 20, 1967).

An exact numerical solution is given of a model for stripping and elastic scattering based on three pairwise interacting spinless particles. Results are given in the absence of a proton–nucleus Coulomb interaction, and when its presence is included approximately. The distorted-wave Born approximation is defined for this model has been calculated exactly and, together with the absorption model, is compared with the exact results. (auth)

44790 COMPREHENSIVE FORMALISM FOR NUCLEAR-REACTION PROBLEMS. II. APPLICATIONS: GIANT RESONANCES AND DOORWAY STATES. Robson, D. (Florida State Univ., Tallahassee); Lane, A. M. Phys. Rev., 161: 982-93 (Sept. 20, 1967).

The formal theory of nuclear reactions introduced in preceding paper is applied to several phenomena of current interest. Particular attention is given to the derivation of a single-level form for the transition amplitude, the interpretation of this form being dependent on the physical situation involved. Under certain conditions the single-level form is appropriate for the description of an isolated resonance; under other conditions it corresponds to a giant resonance. The width of the giant resonance is discussed in detail, in particular the possibility of observing the so-called "spreading" width. The theory is used to describe "doorway" states and their connection with giant resonances. Some clarification of the relation between earlier alternative approaches to this problem is obtained. The occurrence of statistical fluctuations near a giant resonance is considered and leads to the suggestion that fine structure and gross structure are intimately connected, the actual connection being simple in some cases. Several of these results are illustrated by considering the phenomena of isobaric analog resonances within the framework of the present formalism. (auth)

44791 STRETCH SCHEME, A SHELL-MODEL DESCRIPTION OF DEFORMED NUCLEI. Danos, Michael; Gillet, Vincent (CEN, Saclay, Gif-sur-Yvette, France. National Bureau of Standards, Washington, D. C.). Phys. Rev., 161: 1034-44(Sept. 20, 1967).

A good angular-momentum wave function containing the maximum possible intrinsic angular momenta leads to a microscopic description of the nuclear rotational spectra in terms of spherical shell-model states. The rotational excitation energies arise from the residual two-body force. In the actual model calculations, the only approximation was a partial violation of the exclusion principle. The computed departures from the $I(I+1)$ law are consistent with experiment. Reasons are given for the preference of positive over negative intrinsic deformations. (auth)

44792 ANGULAR DISTRIBUTION OF THE NEUTRINO IN MUON CAPTURE AND NUCLEAR STRUCTURE. Morita, M. (Columbia Univ., New York). Phys. Rev., 161: 1028-34(Sept. 20, 1967). (NYO-1932-118).

As a result of parity nonconservation, emitted neutrinos in muon capture by spin-zero nuclei have an asymmetric angular distribution with respect to the muon-polarization axis. The asymmetry coefficient α is defined by the distribution $1 + \alpha P \cos\theta$, and it is given in cases in which the final states have definite spin and parity. In the unique forbidden transitions in which the final states have spin J and parity $(-)^{J+1}$, α is generally dependent on both nuclear structure and the pseudoscalar coupling constant C_p. However in some cases, it is almost independent of nuclear structure, so that we can study the magnitude of C_p from the asymmetry coefficient. In the nonunique forbidden transitions in which the final states have spin J and parity $(-)^J$, α is independent of C_p, but is strongly dependent on nuclear structure. As extreme cases, α is +1 for A-type and −1 for V-type giant dipole excitations, with about 2% estimated error. This holds also for A- and V-type higher multipole excitations. If the final states are 0^- or 0^+, then α is exactly −1, and this case is independent of both nuclear structure and the magnitude of C_p, in contrast to the strong dependence of the capture rate on C_p in the 0^- states. An averaged value of α over four kinds of the giant dipole states is equal to 0.4, in agreement with Primakoff's value in the closure approximation. (auth)

44793 UNITARY-MODEL-OPERATOR APPROACH TO NUCLEAR-STRUCTURE PHYSICS. II. APPLICATIONS. Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge); Waghmare, Y. R.; Tomaselli, M.; Hull, M. H. Jr. Phys. Rev., 161: 1015-27 (Sept. 20, 1967). (MIT-2098-263; MIT-2098-312; YALE-1807-40).

Results are reported for Hartree-Fock calculations carried out with an effective interaction derived from the Yale potential. The spherical nuclei ^{16}O and ^{40}Ca are considered. The orbitals are expanded in terms of harmonic-oscillator functions, and the dependence of the results on the number of oscillator functions used and upon the oscillator size parameter is studied. The importance of various second-order terms is considered using a simple approximation for the Pauli operator and the energy denominators. For the second-order terms in the tensor interaction, some spectral corrections to the simplified energy denominators are made. Reasonable results are obtained for the nuclei considered; however the spectral corrections to the simplified energy denominators are found to provide an important correction to the calculated binding energy. It is concluded that an improved treatment of the energy denominators is required to improve the accuracy of the results reported. Tables of the effective interaction used in these calculations are presented. (auth)

44794 UNITARY-MODEL-OPERATOR APPROACH TO NUCLEAR-STRUCTURE PHYSICS. I. Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge); Waghmare, Y. R.; Hull, M. H. Jr. Phys. Rev., 161: 1006-14(Sept. 20, 1967). (YALE-1807-39; MIT-2098-262).

A discussion of the unitary-model-operator approach to the correlation problem in nuclei is presented and some calculational details are discussed. The renormalization of the tensor force is carried out in second-order perturbation theory after the introduction of a set of correlated basis functions. It is indicated that the application of the Hartree-Fock method to the resulting effective Hamiltonian extends the range of application of the theory for

which a degree of self-consistency in the calculations may be achieved. (auth)

44795 SEMIEMPIRICAL FORMULA FOR NUCLEAR ROTATIONAL ENERGIES. Sood, P. C. (Univ. of Alberta, Edmonton). Phys. Rev., 161: 1063-70(Sept. 20, 1967).

Using the theory of molecular spectra to obtain an estimate of the higher-order corrections to the energy levels of a nonrigid rotator, the infinite power series in $I(I+1)$ is summed to describe the energy levels in the ground-state rotational bands of deformed even-even nuclei by the expression $E(I) = A(I)I(I+1)$, where $A(I) = A[1 + (N-1)(B/A)I(I+1)]/[1 + N(B/A)I(I+1)]$, with $N = 2.85 - 0.05I$. The predictions of this two-parameter formula show surprisingly good agreement with the experimentally observed energy levels in even-even nuclei in the rare-earth region, including Os isotopes and N = 90 nuclei. Comparison with other relatively successful models advanced during the recent years, e.g., the Davydov-Chaban model as adopted by the Berkeley group, the cranking-model extension by Harris, the classical hydrodynamical model used by Moszkowski, the rotator-vibrator model, the asymmetric-rotator model, etc., reveals a distinctly greater success of our description when it is applied to such a wide range of nuclei. (auth)

44796 EXACT SHELL-MODEL CALCULATION OF ^{58}Ni AND ^{60}Ni. Gambhir, Y. K.; Raj, Ram (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 161: 1125-31(Sept. 20, 1967).

Exact configuration-mixing calculations were done for ^{58}Ni and ^{60}Ni, which have two and four neutrons, respectively, in unfilled shell-model orbitals. Several different types of effective potentials were used; they are: the surface-delta interaction, Serber exchange, a potential similar to the Rosenfeld mixture, an approximate reaction matrix calculated with the Hamada-Johnston two-nucleon potential, and Tabakin's nonlocal separable two-nucleon potential. These results are compared with those obtained by using the two-body matrix elements given by Cohen et al. (EIC) and by Auerbach (EIA). The overlap of the BCS projected wave function with the exact shell-model ground-state wave function is calculated. The odd-even mass difference obtained from pairing theory using these potentials is compared with the experimental values. It is found that the first three potentials give nearly the same quantitative results as that calculated with EIC and EIA, while the Hamada-Johnston and Tabakin potentials are rather weak. (auth)

44797 ft VALUES OF SOME $0^+ \rightarrow 0^+$ BETA DECAYS AND THE VALUE OF THE VECTOR COUPLING CONSTANT. Chern, B.; Halpern, T. A.; Logue, L. (Univ. of Florida, Gainesville). Phys. Rev., 161: 1116-18(Sept. 20, 1967).

The correct changes in the f_0t values for some $0^+ \rightarrow 0^+$ nuclear B decays due to the radiative corrections are calculated and compared with the different results obtained by using the radiative corrections as given by Kinoshita and Sirlin, by Källén, and by the present authors. The calculation of the radiative correction differs from the others in making use of a configuration space cutoff, which is what appears in the Fermi function. The screening effects, due to the orbital electrons on the Fermi function, are treated analytically in the perturbation theory to order $Z\alpha$, and agree precisely with Rose's results. The corrected values for G_β and $(G_\mu - G_\beta)/G_\mu$ are given, as well as a table explicitly delineating the percentage corrections to the f_0t values due to screening, radiative corrections, and finite nuclear size. (auth)

44798 LOW-ENERGY SPECTRA OF ODD-MASS Tc AND Ru ISOTOPES. Goswami, A. (Case Inst. of Tech., Cleveland. Western Reserve Univ., Cleveland); Sherwood, A. I. Phys. Rev., 161: 1232-5(Sept. 20, 1967).

A possible explanation is given for the "anomalous" low-lying levels of the odd-mass Tc isotopes in terms of the theory of extended quasiparticle-phonon coupling, with the precision of low-lying high-spin levels. It is checked that the same parameters used in the Tc calculation give a reasonable fit to the low-energy spectra of Ru isotopes. In particular, these calculations account for the anomalous high density of low-lying states in the Ru isotopes. (auth)

44799 MAGNETIC MOMENTS OF TWO-QUASIPARTICLE STATE OF DEFORMED NUCLEI. Grigor'ev, E. P.; Zolotavin, A. V.; Sergeev, V. O. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1176-84(July 1966). (In Russian).

Although up to now the study of excited states of even-even deformed nuclei yielded information only about the magnetic moments of the lower rotational levels and the gyromagnetic relations, g_R, of their collective motions in the nucleus. Recently the magnetic moment, μ, of the 2-particle state was directly measured or estimated on the basis of the probability of M1 transitions within the rotational band at the 2-particle level. Such measurements may also be carried out by the same method for odd-odd nuclei. Estimates were made using experimental data concerning the magnetic properties of highly excited states of the even-even nuclei ^{156}Gd, ^{168}Dy, ^{172}Yb, and ^{182}W. It was concluded that transitions in the rotational band of the 2-quasiparticle state allow one to determine the magnetic moments of these states, whereby it may be assumed that the quadrupole moments Q_{ii} of these states differ only slightly from the ground states Q_{00} of even-even nuclei. The magnetic moments of the excited states of ^{168}Dy, ^{172}Yb, and ^{182}W were determined by this method; the μ value of the excited state of ^{156}Gd was determined on the basis of the intensity of γ transitions from the level of the rotational band. The data agreed with theoretical values; the occasional divergences indicate that the theory of magnetic moments of the 2-quasiparticle levels must be further developed, considering spin-spin interactions and the effect of unpaired nucleons on the polarization of the core of the nucleus. (TTT)

44800 PHASE TRANSFORMATION OF SPHERICAL INTO NONSPHERICAL NUCLEI. Nosov, V. G. Zh. Eksp. Teor. Fiz., 53: 579-91(Aug. 1967). (In Russian).

A phenomenological theory is developed for phase transformation of spherical nuclei into nonspherical ones. It explains the sudden, discontinuous appearance of equilibrium deformation of the nucleus and also the nonsymmetric growth of the amplitudes of the zero-deformation oscillations near the transition point as deduced from α-decay data. The theory predicts degeneracy of the nonspherical nucleus mass coefficient at the transition point in accordance with the law $(N-N_c)^{\frac{1}{2}}$ which agrees with the few data pertaining to octupole oscillations of heavy nuclei. (auth)

44801 TENSOR FORCES IN PAIR INTERACTIONS. Sliv, L. A.; Kharitonov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1086-9(July 1966). (In Russian).

In pair interactions, the central forces play a more important role than the tensor forces; the latter must be determined on the basis of the breaking of the configuration, determining the cases in which the contribution of the central forces is at a minimum. One of these cases is the breakup of the $(n's_{\frac{1}{2}},nlj)$ - type n-p configuration, i.e., when the neutron or neutron hole is in a $n's_{\frac{1}{2}}$ configuration of the proton or the proton hole is an arbitrary nlj state or vice versa. Formulas were derived to indicate the dependence of the absolute value of the breakup of the doublets on the angular portion of the wave functions of the orbital quantum l. This criterion is considered to be well suited for determining the tensor component in pair interactions, as encountered in ^{16}N and ^{206}Tl nuclei. It was found that for ^{16}N, the breakup of the $(1d_{\frac{5}{2}},1p_{\frac{1}{2}})$ configuration is due primarily to singlet forces. In the case of the ^{206}Tl nucleus, the tensor force parameter $V_t \approx 8$ to 10 MeV, but the contribution of tensor forces in the other configurations of that nucleus is small and the experimentally obtained values are due to configuration interaction. (TTT)

44802 COLLECTIVE NUCLEAR STATE IN TAMM-DANCOFF METHOD. Fogel', P. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1095-1100 (July 1966). (In Russian).

Many properties of collective nonrotational states in deformed and spherical nuclei could be explained by means of the microscopic model of the nucleus, which is based on the Hamiltonian corresponding to terms of the mean field and the interaction of the particles. For the solution, a quasiboson approximation is used, assuming that the pair of quasiparticle operators possesses the commutational properties of a Bose operator. The Hamiltonian appears in a quadratic form in the new operators and may be diagonalized by either unitary transformation, the Tamm-Dancoff approximation, or by the Bogolyubov transformation. An attempt was made to solve this problem within the evaporation-multipole interaction model for the case in which the energy of the collective level differs only slightly from the energy of the two-quasiparticle state. In this case even-even deformed nuclei are often encountered. The study was based on the Tamm-Dancoff method, assuming that the ground state of the even nucleus is a quasiparticle vacuum. The collective states of even-even deformed and odd nuclei were considered. (TTT)

44803 QUASISTATIC PERTURBATIONS OF ANGULAR CORRELATIONS. Klyucharev, V. A. (Physical-Technical Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 30: 1101-6(July 1966). (In Russian).

The study of extranuclear perturbations in angular correlations yields information on the magnetic and electric moments of the excited nuclei and on the microfield within the matter. In most cases, liquid sources are used for these measurements; as in such cases the perturbations of angular correlations by internal fields exhibit a statistic character. Abragam and Pound's theory of statistical excitation agrees with measurements when nonviscous liquid sources are used; i.e., when the correlation time τ_c is the

liquid source (usually 10^{-11} to 10^{-7} sec) it is much smaller than the lifetime τ of an intermediate state in the nuclear cascade. Statistical perturbation exists when the condition $\tau_c \ll \tau$ is not fulfilled. It was found that the expression for the perturbation factor of the correlation function in the case of a statistical interaction with relatively slowly changing nuclear media allows one to interpret the data obtained by perturbation of angular correlations using viscous fluids and amorphous solids. The formulas may be used to estimate the amount of admixtures with quasistatic perturbation in the commonly used liquid sources. Study of the quasistatic perturbation allows one to measure directly the mean frequency of the quadrupole precession. (TTT)

44804 CHARGE FORM FACTORS AND CHARGE DISTRIBUTIONS OF ^{3}H AND ^{4}He. **Tang, Y. C. (Univ. of Minnesota, Minneapolis); Herndon, R. C. Phys. Lett., 25B: 307-9(Sept. 18, 1967).**

The charge form factors and charge distributions of ^{3}H and ^{4}He are calculated from wave functions obtained with nucleon–nucleon potentials which contain a hard core. (auth)

44805 SELF-CONSISTENT TREATMENT OF NUCLEAR ROTATION. **Husain, D. (Dacca Univ., Pakistan). Proc. Phys. Soc. (London), 91: 581-6(July 1967).**

The moment of inertia of the ^{28}Si nucleus is calculated using the formalism developed by Thouless (Nuclear Phys., 21: 225-32 (1960)) and by Peierls and Thouless (Nuclear Phys., 38: 154-76 (1962)). The approximate Hartree–Fock single-particle wave functions are chosen to be the harmonic oscillator wave functions with only two parameters, which were determined by minimizing the ground-state expectation value of the Hamiltonian, and the two-body interaction is taken to be the Rosenfeld mixture with Gaussian form. A check on the self-consistency of the problem is made by calculating the mass of ^{28}Si. The values of the moment of inertia obtained are rather less than the rigid-body value. (auth) (UK)

44806 PROJECTED HARTREE–FOCK CALCULATIONS FOR LIGHT NUCLEI. III. ELECTROMAGNETIC PROPERTIES OF ^{7}Li. **Bouten, M. (SCK, Mol, Belg.); Bouten, M.-C.; Van Leuven, P. Nucl. Phys., A102: 322-8(1967).**

The wave functions for the ground state and the lowest two excited states of ^{7}Li obtained from a projected Hartree–Fock calculation are used to calculate the quadrupole moment, the E2 transition probability from the 0.478 MeV level, and the form factor for inelastic electron scattering to the 4.63 MeV level. Good agreement with experimental data is achieved. (auth)

44807 SECOND-FORBIDDEN CONTRIBUTIONS TO ALLOWED ISOSPIN HINDERED $J \rightarrow J$ TRANSITIONS. **Coussement, R.; Van Neste, L. (Leuven Univ., Belg.). Nucl. Phys., A102: 363-8(1967).**

The importance of possible second-order contributions in the determination of the Fermi matrix element in $J \rightarrow J$ allowed β-transitions is considered. Some theoretical estimations of the second-forbidden matrix elements are discussed. It is found that no results concerning isospin impurities can be deduced from a number of the experimental results, if no more information about second-forbidden contributions is yielded. It is stated that only the study of $0^+ \rightarrow 0^+$ transitions can give some experimental information about these contributions. (auth)

44808 SU(3) CLASSIFICATION OF NUCLEAR WAVE FUNCTIONS IN MIXED 1p, 1d–2s SHELLS. **Yano, Fleur B. (California State Coll., Los Angeles). Nucl. Phys., A102: 376-82 (1967).**

Wave functions which span irreducible representations of the SU(3) group are constructed from shell-model functions which belong to configurations $(1p)^{10}(2s \text{ or } 1d)$. The energy centroid and width of these states are computed, and the SU(3) structure in the even-parity states of ^{15}N are discussed. (auth)

44809 PRESSURE DEPENDENCE OF MOESSBAUER ENERGY SHIFT. **Mahesh, Krishan (Kurukshetra Univ., India). Nucl. Instrum. Methods, 54: 212-16(Oct. 1967).**

Expressions for Mössbauer energy shift are obtained in a direct and simple form, at high, medium, and low temperatures, using the infinite series expansion of the Debye integral, involving Bernoulli's numbers. The effect of pressure on the shift at low temperatures is arrived at through the dependence of the Debye temperature on pressure in the Grüneisen approximation. The effect of pressure on the energy shift is investigated for a number of radioisotopes in the pressure range of 0–300 kbar. Results for ^{57}Fe are compared with earlier work. The variation of the Grüneisen parameter in terms of the atomic parameters of the elements is considered. It is felt that the value of the parameter for other elements also, obtained experimentally or otherwise can be analytically fitted and normalized to the obtained variation of the Grüneisen parameter. (auth)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 42962, 43016, 43087, 43089, 43152, 43159, 43162, 43173, 43176, 43443, 43552, 43602, 43651, 43655, 44496, 44497, 44528, 44534, 44541, and 44932.

44810 (AD–648806) THE GRAND CANYON CONTROVERSY, 1967: FURTHER ECONOMIC COMPARISONS OF NUCLEAR ALTERNATIVES. Carlin, Alan P.; Hoehn, William E. (RAND Corp., Santa Monica, Calif.). Mar. 1967. 20p. (P–3546). CFSTI.

New calculations incorporating revised cost estimates of the nuclear powerplant alternatives and reflections of the increased importance of one of the proposed dams, the Hualapai (formerly Bridge Canyon) Project are presented. The new calculations also introduce several refinements on earlier methods. (auth)

44811 (AD–648807) WHAT THE PARSONS STUDY REALLY SAYS ABOUT NUCLEAR POWER ECONOMICS: THE GRAND CANYON CONTROVERSY, ROUND. Hoehn, William E. (RAND Corp., Santa Monica, Calif.). Mar. 1967. 27p. (P–3548). CFSTI.

The principal conclusions of the Parsons study are: Comparing nuclear alternatives with the hydroelectric plants on a peaking basis shows that the nuclear plants themselves will never pay out since the annual interest payments are greater than the net revenues as demonstrated in the Consolidated Payout Schedules herein. This study also compares the funds accumulation from a baseloaded nuclear plant with those accumulated from the hydroelectric plants. While this comparison accrues the most funds from the various nuclear alternatives considered in this study, the funds accumulated are substantially less than those accumulated from the hydroelectric plants. Even at the federal financing interest rate of 3.222%, the baseloaded nuclear power plants could not repay their costs if it were not for the outside contributions to the combined fund of revenues from Hoover, Parker, and Davis Dams in later years of the analysis. Evaluating only the economics of nuclear energy production at the plants — by neglecting all transmission costs — the four nuclear plants, baseloaded, could not repay their costs if the aggregate fixed charge rate (including depreciation) were in excess of 6.1% per annum. (auth)

44812 (AECL–2945) FACTORS AFFECTING THE DESIGN OF RODDED UO_2 FUEL BUNDLES FOR HIGH POWER OUTPUTS. Notley, M. J. F.; Lane, A. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1967. 22p. (CONF-670917–2). Dep. CFSTI. CAN $1.00.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

Bundle power output is limited by the heat that can be removed by the coolant, due to approach to a critical heat flux condition, limitations imposed by coolant temperatures, or the onset of bulk boiling. These conditions are affected by the degree of subdivision of the bundle, the coolant flow rate and the mixing characteristics between bundle subchannels. Higher bundle power outputs can generally be obtained by more extensive subdivision of the fuel and higher flows, but problems of vibration, fretting and pressure drop may become more acute. Also, subdivision incurs greater fabrication costs and loss of reactivity. The limitations to the maximum power output of the single elements that make up a bundle stem from the requirement that the elements should remain dimensionally stable; this is to avoid impairment of sheath integrity, blockage of coolant subchannels, or differential strains that might destroy inter-element linkages. Since an increase in element power output would raise the fuel temperature and hence volumetric expansion and fission product gas release, there must therefore be a corresponding increase in available void volume, and a decrease in the amount of UO_2. Such an increase in void volume may necessitate slight increases in sheath thickness, to avoid development of sheath ovality. The greatest uncertainty in operating Zircaloy-sheathed UO_2 at $\int \lambda d\theta$ values over 60 W/cm may be the defect behavior, since power reactor operation demands that the fuel survive several hours at full power in a defected condition. (auth)

44813 (AECL–2949) ENGINEERING AND PERFORMANCE OF CANADA'S UO_2 FUEL ASSEMBLIES FOR HEAVY WATER POWER REACTORS. Page, R. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sept. 1967. 23p. (CONF-670917–3). Dep. CFSTI. CAN $1.00.

From Symposium on Heavy Water Power Reactors, Vienna, Austria.

Significant improvements have been made in design of Zircaloy-2 UO_2 fuel for the Canadian power reactors. A replacement 82.5 mm diameter 19 element bundle (40 W/cm) for the Douglas Point reactor has been developed using a brazed split spacer design, instead of wire-wrap, thus preventing inter-element fretting of the sheath. Both wire-wrapped and brazed split spacer bundles have reached burnups in the range of 10,000 to 20,000 MWd/Te U at heat ratings 15 to 35 W/cm, with a maximum exposure of 1200 coolant days without failures in the NPD reactor. A 103.4 mm diameter 28 element bundle (42 W/cm) has been developed for the 500 MW(e) Pickering Station. Fission gas measurements have indicated a percentage release of less than 5% at 35 W/cm to 20% at 50 W/cm. The percentage release decreases with increased density in the range 10.3 to 10.7 and is independent of burnup up to 8,000 MWd/Te U. Deuterium pickup in operating Zircaloy-2 cladding, exposed to greater than 600 coolant days, has been low. For the Gentilly 250 MW(e) BLW, a fuel bundle (48 W/cm) has been developed to operate at 16% and greater exit steam qualities. Fuel bundles are being tested in the range 40 to 60 W/cm. A cold void volume has been designed into the elements by means of hollow end caps to avoid internal gas pressure exceeding coolant pressure. In-reactor heat transfer tests up to 45% exit quality have shown that the fuel will have a critical power ratio of 1.5. Fuel has been operated at 50% greater than critical power for three hours without significant deterioration of the sheath. Endurance tests on fuel bundles under single phase coolant conditions, and velocities up to 8.8 m/s, have shown that fretting is within acceptable limits. No fretting has been observed with in-pile fuel bundle tests under two-phase coolant conditions at mass velocities up to 440 g/cm^2/s. Future programs for the BLW and PHW reactors will be to increase the fuel rating and the fissile material density. Operation of the BLW fuel elements at high (500°C) surface temperatures will be attempted. In the longer term, both Pu and Th containing fuels will be investigated. (auth)

44814 (AI-CE–42) HEAVY WATER ORGANIC COOLED REACTOR. LONG-TERM STRESS-RUPTURE PROPERTIES OF FINNED SAP CLADDING TUBES. Ferry, P. B.; Glass, D. N. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). Sept. 25, 1967. Contract AT(38-1)-430. 32p. Dep. CFSTI.

The biaxial test facility for HWOCR fuel element cladding designs and the first series of tests designed to evaluate the properties of finished SAP shapes are described. Stress-rupture data are presented for finned tubing of SAP alloys operating in the temperature range of 750 to 950°F. These data are analyzed by Larson-Miller type evaluation to provide extrapolations for predicting material behavior under reactor operating conditions. (H.D.R.)

44815 (AI-CE–66) HEAVY WATER ORGANIC COOLED REACTOR. INVESTIGATION OF TUNGSTEN AS A DIFFUSION BARRIER FOR HWOCR SAP-STEEL PRESSURE TUBE TRANSITION JOINTS. Supan, E. C. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). Sept. 15, 1967. Contract AT(38-1)-430. 29p. Dep. CFSTI.

The Heavy Water Moderated Organic Cooled Reactor requires a transition joint between the SAP 895 pressure tube and the out-of-core carbon steel piping. An intermediate section of stainless steel is metallurgically bonded to the SAP tube and welded to the carbon steel. A tungsten barrier layer (applied by chemical vapor deposition) is used at the SAP-stainless steel joint interface to prevent the formation of brittle intermetallic compounds by diffusion between stainless steel and aluminum during the 30-year design life of the pressure tube at temperatures to 765°F. A study was conducted to determine the extent of diffusion that could be expected between the constituents of the bond system, particularly between SAP 895 and tungsten, due to the time-temperature conditions of reactor service. It was concluded that the maximum diffusion layer that could be expected between SAP 895 and tungsten after 30 years at 765°F is 0.000108 in., which is not considered detrimental to the transition joint tensile strength. (auth)

44816 (AI-CE–78) HEAVY WATER ORGANIC COOLED REACTOR. FABRICATION OF SAP-CLAD URANIUM CARBIDE FUEL ASSEMBLIES FOR THE HWOCR IRRADIATION TESTING PROGRAM. Jackson, W. R. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn. [Nuclear Div.]). Sept. 15, 1967. Contract AT(38-1)-430. 39p. Dep. CFSTI.

The materials (SAP and UC), critical processes (eutectic bonding of fuel rod end closures), general design criteria, and current status are described for six fuel element assemblies fabricated for the irradiation test program. (auth)

44817 (AI-CE-87) HEAVY WATER ORGANIC COOLED REACTOR. STATUS AND POTENTIAL, JUNE 1967. (Atomics International, Canoga Park, Calif. Combustion Engineering, Inc., Windsor, Conn.). Aug. 31, 1967. Contract AT(38-1)-430. 129p. Dep. CFSTI.

The technical status of the Heavy Water Organic Cooled Reactor (HWOCR) concept is summarized. The HWOCR concept is commercial feasibility for central station power generation. The HWOCR concept is commercial feasibility for central station power generation. The HWOCR is an advanced converter reactor with the following capabilities projected to be generation of electric power at competitive cost, high utilization of natural resources of fissile materials, and relatively simple extrapolation to the very large plant sizes required for both the economic generation of electric power and the economic production of water for domestic and agricultural use. While additional development work remains to be performed at the conclusion of the program, all the information available indicates that the HWOCR concept is technically feasible and capable of meeting its objectives. The concept, the plant design, economics, and fuel utilization, and the technical status and results of the development program are given. (J.C.W.)

44818 (APDA-203) DESIGN OF THE RADIATION SHIELD SYSTEM FOR THE ENRICO FERMI ATOMIC POWER PLANT. Beaudry, R. J.; Hungerford, H. E.; Mantey, R. F.; Chaltron, W. F. (Atomic Power Development Associates, Inc., Detroit, Mich.). May 1967. 96p. Dep. CFSTI.

Design considerations for the Fermi Fast Breeder are presented. These include high fast neutron leakage to the shield due to small core size, and thin blanket construction. The neutron energy is relatively high due to lack of moderator in a core–blanket system. In fast breeder reactors moderator materials are not usually allowed within the reactor vessel because of safety factors. Shielding must be provided for the cooling system as well as the reactor. This is because of the requirement of liquid metals as coolants due to high-temperature operation of a fast breeder. Detailed descriptions are presented for the shield systems for the reactor building and auxiliary buildings. Economic considerations are discussed. (M.L.S.)

44819 (BMI-X-10186) FISSION-PRODUCT DEPOSITION AND ITS ENHANCEMENT UNDER REACTOR ACCIDENT CONDITIONS. Quarterly Progress Report, October–December 1966. Genco, Joseph M.; Berry, David A.; Berry, Warren E.; Rosenberg, Harvey S.; Cremeans, George E.; Morrison, David L. (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1967. Contract W-7405-eng-92. 48p. (EURAEC-1809). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A detailed study of fission product deposition in containment systems is presented. Fission product deposition on Zircaloy-4 and Type 304 stainless steel is presented as a function of temperature. Atmospheric effects on mass transfer rate measurements for I_2 are evaluated. Adsorption–desorption kinetics for elemental I_2 plateout are analyzed. I_2 deposition on various types of containment coatings is detailed. 8 references. (M.L.S.)

44820 (BNWL-450) FCC-IV: A REVISED VERSION OF THE FCC FUNDAMENTAL MODE FAST REACTOR CODE. Little, W. W. Jr.; Hardie, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 134p. Dep. CFSTI.

FCC-IV is a multipurpose fundamental mode code for use in fast reactor neutronics analysis. The code can be used to: compute resonance shielded cross sections using data in the Russian format; compute the fundamental mode flux and adjoint flux; compute and punch collapsed microscopic, macroscopic, and perturbation cross sections; and compute fuel burnup at constant flux or power density. In a 65 K memory, the code can handle 14 isotopes with 40 energy groups and 10 downscattering terms. Running time on a UNIVAC 1108 is about 15 sec. (auth)

44821 (BNWL-SA-1139(Rev.A)) UO_2–PuO_2 FUEL RODS FOR THE EXPERIMENTAL BOILING WATER REACTOR. Sharp, R. E.; Bailey, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 5, 1967. Contract AT(45-1)-1830. 48p. (CONF-671101-2(Rev.A)). Dep. CFSTI.

From Annual Meeting of the American Society of Mechanical Engineers, Pittsburgh, Pa.

The first Pu-fueled boiling water reactor to deliver useful electrical power was the Experimental Boiling Water Reactor. The 36 central core assemblies contained 1296 vibrationally-compacted, Zircaloy-clad, UO_2-1.5 wt % PuO_2 fuel rods (31 lb of Pu, total). The EBWR Plutonium Recycle Demonstration Experiment required preparation of 2250 rods for core and physics tests and included over 1870 kilograms of impacted mixed oxide and over 11,000 feet of fuel rods. Some considerations involved in the design, fabrication, and irradiation proof testing (27,600 MWd/tonne burnup achieved in other reactors) are discussed. (auth)

44822 (BNWL-SA-1199) THE EBWR PLUTONIUM RECYCLE DEMONSTRATION EXPERIMENT. Bean, C. H.; Sharp, R. E.; Bailey, W. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 5, 1967. Contract AT(45-1)-1830. 29p. (CONF-671005-1). Dep. CFSTI.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

Development of UO_2–PuO_2 fuel elements for the EBWR is outlined. Fabrication, quality control testing, and irradiation testing are discussed. 18 references. (M.L.S.)

44823 (CEA-R-3221) INTERCORRELATION DE DEUX DETECTEURS DANS UN REACTEUR NUCLEAIRE. (Cross-Correlation of Two Detectors in a Nuclear Reactor). Dalfes, Abdi; Beliard, Lucien; Cazemajou, Jean; Froelicher, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1967. 59p. (In French). Dep.

Auto and cross-correlation functions of signals given by neutron detectors situated in a subcritical nuclear reactor are determined by a numerical method. Values of the prompt neutrons decay constant obtained by means of the autocorrelation function of each detector and the cross-correlation function of the two detectors are compared to the reference value given by a classical pulsed neutrons measurement. Agreement between results is satisfactory. (auth)

44824 (CVNA-274) DESIGN, FABRICATION, AND OPERATION OF THE CVTR HIGH POWER, HIGH-BURNUP TEST ASSEMBLIES. Balfour, M. G.; Foster, E. S.; Ferrari, H. M.; Paxson, E.; Kortheuer, J. D.; Watley, L. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967. Contract AT(30-1)-2289. 102p. Dep. CFSTI.

For Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.

Four special test assemblies were designed to achieve high power levels and burnups beyond the present conservative operating limits for power reactors. Each test assembly consists of six UO_2 rods and 13 dummy Al_2O_3 rods, clad with either freestanding or thin-wall Zircaloy-4 and alternatively with stainless steel. The UO_2 rods were designed for 25.08 and 20.90 kW/ft and peak burnups of 50,000 and 41,670 MWD/MTU, respectively. A detailed description of the test assemblies from the standpoint of irradiation, mechanical, thermal and hydraulic, and nuclear design is given. Fabrication of the assemblies is reviewed. An operation history for the assemblies is presented. Three of the four test assemblies developed defects, and irradiation was terminated prematurely. An analysis of cladding behavior of the assemblies based upon their power history has been performed. (auth)

44825 (CVNA-288) PERIODIC ULTRASONIC INSPECTION OF CVTR PRESSURE TUBES. Paxson, E.; Hornak, L. P.; Jones, M. B. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). June 1967. Contract AT(30-1)-2289. 53p. Dep. CFSTI.

For Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.

The design, fabrication and use of equipment to perform nondestructive examinations, using ultrasonic techniques, of irradiated CVTR Zircaloy-4 pressure tubes at intervals during plant life are summarized. The results of examination of 10 irradiated and 8 unirradiated pressure tubes indicated that the CVTR pressure tubes operated entirely satisfactorily. (auth)

44826 (DP-1101) METALLURGICAL INVESTIGATION OF ALUMINUM-CLAD CADMIUM CONTROL RODS. Ondrejcin, Robert S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sept. 1967. Contract AT(07-2)-1. 17p. Dep. CFSTI.

Cd (mp 321°C) clad with Al was used satisfactorily for control rods for a water-cooled nuclear reactor operating at a neutron flux of $\sim 10^{15}$ n/(cm^2)(sec). Laboratory tests, to assure the integrity of this combination, had shown that Al is attacked very slowly by molten Cd at 400 to 600°C under conditions of static stress and also under continuous strain. The Al cladding of two control rods used in operation at high flux was not attacked even though the Cd had partially melted in one rod during reactor operation. (auth)

44827 (DP-MS-66-70) COMPUTATIONAL TECHNIQUES AND RESOURCES. Clark, Hugh K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Oct. 3, 1966. Contract AT(07-2)-1. 20p. (CONF-661206-6). Dep. CFSTI.

From American Nuclear Society, National Topical Meeting, Nuclear Criticality Safety, Las Vegas, Nev.

Computational problems in criticality safety are presented.

Requirements and approximations necessary to simplify calculations and allow computerization are discussed. 16 references. (M.L.S.)

44828 (EUR-3493e) DEVELOPMENT OF HIGH-TEMPERATURE THERMAL REACTORS IN GERMANY. Hecker, R.; Rausch, W.; Schulten, R. (Brown Boveri/Krupp Reaktorbau G.m.b.H., Duesseldorf (West Germany). Kernforschungsanlage, Juelich (West Germany)). Apr. 12, 1967. Contract 003-61-1 RGAD. 32p. (CONF-661213-1). Dep.

From 9th International Meeting on Nuclear Energy, Milan, Italy.

The first efforts for the development of high temperature thermal reactors in Germany include the AVR pebble bed reactor being completed and the critical experiments performed. The work for the development of gas turbines for use with high temperature reactors has reached a point where tenders have been submitted for a 25 MW(e) closed-cycle gas turbine prototype plant. The THTR-Project for the development of a 300 MW(e) prototype reactor representative of full-scale power plants up to 1200 MW(e) shall provide final design documents. Detailed results of these three projects are given and an outlook on the further development with special regard to the potential for conversion and breeding is given. (auth)

44829 (EUR-3610f) COMPLEMENTS AUX ETUDES PARAMETRIQUES DES REACTEURS A EAU NATURELLE. THERMALISATION DES NEUTRONS DANS UN REACTEUR A EAU NATURELLE ET CODE COELACANTHE. (Supplements to Parametric Studies on Natural-Water Reactors. Thermalization of Neutrons in a Natural Water Reactor and COELACANTH Code). Elkouby, A.; Mahe, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1967. 120p. (In French). Dep.

The COELACANTH code was developed. From the general form of the thermalization using the Cadilhac differential model, the equations explicitly in a heterogeneous cell with cladding were written. A determination of the disadvantage factor using the collision probabilities in the three media making up the cell were used; these probabilities were related to the Dancoff effect. For this effect a single-parameter tabulation of A. Sauer was used. The solution makes it possible to obtain the neutron spectrum in the fuel and consequently to calculate the cross-sections for the different isotopes. Finally, ignoring leaks, the different thermalization models, namely the Egelstaff model, the Wigner Wilkins model and the heavy-gas mode were compared. Comparisons were made with the THERMOS code. The fuel burn-up by means, firstly, of a multigroup method and, secondly, of a code using the secondary model for the two types of steel and Zircaloy cladding was calculated. A brief comparison was made with the partial experimental results for the YANKEE core at 8400 MWd/t. A method for calculating the spectrum and effective cross-sections in the case of a spectral shift by a mixture of H_2O and D_2O moderator is described. (auth)

44830 (GA-7396) HTGR BASE PROGRAM. Quarterly Progress Report for the Period Ending August 31, 1966. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 15, 1966. Contract AT(04-3)-167. 58p. Dep. CFSTI.

PRESSURE VESSELS — testing of high temperature gas cooled reactor prestressed concrete
REACTORS, GAS-COOLED — pressure vessels for high temperature, development of prestressed concrete; fuel elements for high temperature, design effects on reprocessing of; kinetics computer codes for high temperature, development of space-time; fuel cycle for high temperature, economics of
GAMMA RADIATION — buildup in heterogeneous media of, calculation of; flux calculations using transport theory, effects of quadrature on
IN-PILE LOOPS — fuel element irradiated in GAIL, postirradiated testing of
REACTOR FUELS — radiation effects on coated particle, tabulation of GAIL IV; cycle economics for high temperature gas-cooled; coatings for, development of barrier; diluent particles in, chemistry studies of; irradiation of coated particle, results of
URANIUM ISOTOPES U-238 — resonance absorption as a function of lattice parameters, calculation of
FISSION PRODUCTS — deposition on stainless steel specimen from GAIL IV fuel element; deposition in stainless steel pipe downstream from GAIL III-B fuel element; release from beryllia fuel compact of steady-state gaseous
FILTERS — radiochemical analyses of GAIL IV main loop, results of
REACTOR FUEL ELEMENTS — reprocessing of high temperature gas-cooled, effects of fuel element design on; reprocessing of high temperature gas-cooled, economics of
COATINGS — behavior of silicon carbide reactor fuel, effects of strongly corrosive atmosphere on; fission product release from barrier
NEUTRON CROSS SECTIONS — evaluation of uranium 233
PLUTONIUM — diffusion studies on
GRAPHITE — radiation effects at high temperatures on; thermal expansivities of isotropic and anisotropic (M.L.S.)

44831 (GA-8089) EBOR CONTROL ROD DRIVE SPEED REDUCER TEST. Nicoll, D.; Anderson, J. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). June 30, 1967. Contract AT(04-3)-187. 96p. Dep. CFSTI.

The development of a dry-film lubricated speed reducer for the Experimental Beryllium Oxide Reactor (EBOR) control rod drive mechanism is described. The speed reducer consists of five stages of spur gear reduction which provides an overall speed reduction of 720 to 1, with alternate output speeds of approximately 2.4 and 0.8 rpm. The normal torque loading at the output of the speed reducer is 125 in.-lb. The first interim report on the EBOR Control Rod Drive Development Program, GA-7038, was published on March 23, 1966 and includes information on the design and testing of the Phase-I mechanism. The record interim report on this program was published in November, 1966 and describes the Phase-II program in detail. (auth)

44832 (GA-8104) USE OF AN ON-LINE REACTIVITY COMPUTER TO CALIBRATE CONTROL RODS AT POWER. Long, H.; Schlicht, R.; Van Howe, K.; Weiman, A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 12, 1967. Contract AT(04-3)-314. 14p. (CONF-670713-9). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

An on-line reactivity computer is used to calibrate control rods during power operation of the Peach Bottom HTGR. The reactivity computer is a solid state analog device specifically developed to compute core reactivity as a function of time. The computer solves the point kinetics equation for the reactor using six delayed neutron groups. The core reactivity and the positions of any three control rods are displayed on two 2 pen recorders. Since the on-line reactivity computer instantaneously displays core reactivity, it is not necessary to obtain a stable reactor period. The heat capacity of the core of the Peach Bottom reactor is relatively large and therefore the core temperature change and the accompanying reactivity feedback during the time of a small rod motion at power worth approximately 10 cents is small. The reactivity computer therefore yields, to first order, the reactivity change produced by only the control rod change. Even though the error due to the reactivity feedback during the rod movement is small, it can be essentially eliminated by averaging the differential rod worth from a small rod withdrawal and the differential rod worth from an immediate re-insertion of the rod to its original position. During the initial rod withdrawal the temperature feedback produces a negative effect on the measured rod worth. During the subsequent re-insertion the temperature feedback produces a positive effect on the measured rod worth. Averaging these two rod worth measurements eliminates most of any error produced by temperature feedback. These small control rod withdrawals and immediate re-insertions can be performed in a very short period of time and in no way affect the conditions in the plant. A typical trace of the reactivity and the rod position is given for a rod withdrawal and immediate re-insertion at 25 Mw(t). (auth)

44833 (GA-8113) HTGR FUEL ELEMENT PERFORMANCE IN PEACH BOTTOM REACTOR. Turner, R. F.; Duffield, R. B. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 20, 1967. Contract AT(04-3)-314. 12p. (CONF-670713-7). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

The Peach Bottom reactor utilizes fuel elements which each consist of pyrocarbon-coated particles of mixed U–Th carbides dispersed in a graphite matrix contained in a low permeability graphite tube; the tube functions as the main structural member. The reactor core contains 804 fuel elements of this type, each $3\frac{1}{2}$ in. in dia and 12 ft long positioned vertically in a close-packed array. Cooling is accomplished by He gas at 350 psi flowing through the interstices among the elements. The outlet gas temperature is 1340°F. The thermal performance of the fuel at high power has been gratifying and has easily met the design objective of 8.3 kW/liter at an average fuel temperature of approximately 1800°F. The good thermal performance of this fuel has confirmed the objective of high coolant temperature necessary to generate modern steam at 1000°F and 1450 psi. Retention of fission products by the fuel has been very good; the total circulating gaseous fission-product radioactivity in the He coolant inventory has been approximately 200 millicuries at full power. Deposition of solid

fission-product plateout on components of the primary loop has been so low as to allow easy access to primary loop components. (auth)

44834 (GA–8117) PHYSICS PERFORMANCE OF THE PEACH BOTTOM HTGR. Brown, J.; Hopkins, G.; Lane, R.; Merrill, M.; Van Howe, K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 17, 1967. Contract AT(04-3)-314. 18p. (CONF-670713-6). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

During the startup of the Peach Bottom HTGR, measurements were made of the physics performance of the reactor core. Physics measurements were performed during the initial loading of fuel and at low reactor powers (<11.5 kW(t)). The results of these low power tests agreed well with calculated physics performance of the reactor. Initial criticality was achieved with 682 fuel elements loaded compared with a calculated value of 688 fuel elements. The total reactivity worth of control rods was measured by pulsed neutron technique. The measured control rod worths were in good agreement with the calculated worths. For example the measured worth of the control rods in the central rod ring in the just critical core was $0.0222 \pm 0.0014\ \Delta\rho$ compared to a calculated worth of $0.0224\ \Delta\rho$. The flux distribution within the core was measured by traversing a BF_3 chamber in the coolant channels between the fuel elements. As fuel was loaded to the full core loading of 804 fuel elements, differential and total control rod worths were measured by positive period measurements. The results of these measurements agreed with the pulsed source measurements and the calculated rod worths. The measured worth of the three control rods in the central ring was $0.0213\ \Delta\rho$. The reactivity effects of He density and He flow were measured. The temperature coefficient of reactivity from 100°F to 600°F was measured by using the heat input of the He circulators to increase the core temperature. During the low power tests (<11.5 kW(t)) noise analysis measurements were made at various He flow rates through the core. During the escalation of the reactor power from 11.5 kW(t), additional measurements were made. As the reactor power level was increased, measurements of critical control rod positions and fuel element temperatures were made to determine the temperature coefficient of reactivity at operating temperatures. The results of these measurements confirm the agreement between the measured and calculated temperature coefficient obtained at temperatures up to 600°F during the low power test. During power operation, control rods were calibrated using an on-line reactivity computer. The build-up and decay of Xe poisoning following power level changes were also measured. Noise analysis measurements were made at various power levels by recording the output of the power range nuclear channels on magnetic tape. A frequency analysis of these recordings was performed to determine if any resonant frequencies exist in the range from 0.1 to 100 cps. (auth)

44835 (GEAP–5273) FORE II: A COMPUTATIONAL PROGRAM FOR THE ANALYSIS OF STEADY-STATE AND TRANSIENT REACTOR PERFORMANCE. Fox, J. N.; Lawler, B. E.; Butz, H. R. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Sept. 1966. Contract AT(04-3)-189. 206p. Dep. CFSTI.

FORE II is a coupled thermal hydraulics–point kinetics digital computer code designed to calculate significant reactor parameters under steady-state conditions, or as functions of time during transients. The transients may result from a programmed reactivity insertion or a power change. Variable inlet coolant flow rate and temperature are considered. The code calculates the reactor power, the individual reactivity feedbacks, and the temperature of coolant, cladding, fuel, structure, and additional material for up to seven axial positions in three channel types which represent radial zones of the reactor. The heat of fusion accompanying fuel melting the liquid metal voiding reactivity, and the spacial and the time variation of the fuel cladding gap coefficient due to changes in gap size are considered. FORE II is valid only while the core retains its initial geometry. The significant material properties are specified in the input as functions of temperature or pressure, and the external effects as a function of time by tables. The feedback reactivity includes contributions due to the Doppler effect, density changes, dimensional changes (includes bowing and deformation), coolant voiding, and control rods. Any single-phase coolant may be used. Although the code is biased toward fast reactors, it can be used for a thermal spectrum reactor as a steady-state heat transfer code and as a transient point kinetics code. The programming language is FORTRAN IV. A computer with a 32-K storage capacity is required for the operation of FORE II. This document contains a description of the physical model, required input, available options, curve plotting program, and programmed equations. (auth)

44836 (GEAP–5462) ACCURATE NUCLEAR FUEL BURN-UP ANALYSES. Quarterly Progress Report No. 21, December 1966–February 1967. Rider, B. F.; Ruiz, C. P.; Peterson, J. P. Jr.; McLaughlin, T. V. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Apr. 1, 1967. Contract AT(04-3)-189. 91p. Dep. CFSTI.

Improvements were made in the BURNUP computer code for computing U and Pu fuel burnup from U, Pu, and Nd mass spectrometric measurements. The revised computations are given with instructions for preparing input data cards. A list of programmed constants is included. (auth)

44837 (GEAP–5521) POWER REACTOR HIGH PERFORMANCE PROGRAM. Progress Report No. 4, April 1–June 30, 1967. Lees, E. A. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). July 1967. Contract AT(04-3)-189. 22p. (EURAEC–1906). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Radiation testing of fuel rods for power reactors is presented. The fuel rod design is outlined. Critical heat flux tests and analyses are detailed. Axial power distributions vs peaking factors are presented for various fuel subassembly configurations. (M.L.S.)

44838 (GEMP–548) DEVELOPMENT AND CORRELATION OF A METHOD FOR GENERATING SPACE DEPENDENT MULTIGROUP EFFECTIVE CORE CROSS SECTIONS FOR 710 REACTOR ANALYSIS. Henderson, W. B. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). Sept. 25, 1967. Contract AT(40-1)-2847. 71p. Dep. CFSTI.

A method was developed in support of the 710 Reactor Program for generating space-dependent multigroup effective core cross sections. The effective core cross sections, computed in up to 40-zone spatial detail from Doppler broadened Breit–Wigner cross sections, not only improve the accuracy of power distribution calculations where resonance self-shielding is important but also provide a means of computing the Doppler coefficient of reactivity. The method relies on a synthesis of the detailed space-energy core flux distribution from parametric flux traverses generated by a monoenergetic transport approximation. The approximation is primarily in the use of a trial source in the core, for which a correction is subsequently made using the synthesized flux. Errors in zone flux-weighted core cross sections due to the method of flux synthesis were estimated to be 5% or less by comparisons with a 32-group transport calculation of a typical W resonance in the core of the 710 Basic No. 1 critical experiment, a small Oralloy-tungsten core radially reflected by thick Be. Correlation with experimental power distributions and spectral indicators, using the effective multigroup core cross sections in two-dimensional r–z transport calculations, was generally within experimental error and the critical Oralloy density was underpredicted 3%. The largest effect of detailed zone flux-weighting as opposed to flat lethargy-flux weighting of the core cross sections was an 18% increase in the power gradient at the radial core surface. (auth)

44839 (HPR–72) TURBINE FLOW METERS FOR IN-CORE APPLICATION. Schenk, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). June 1967. 21p. Dep.

Turbine flow meters of the standard HBWR design have been extensively used in-core during 1964 to 1966, and have proven to be accurate and reliable. Of the failures experienced, most were in the pick-up coil. All instruments are therefore supplied with two pick-ups. Only a few turbine rotor failures have occurred, and most of these were in forced circulation fuel assemblies experiencing strong flow fluctuations, which increased the wear on the bearings. Modifications of the basic design have been made to permit operation in channels of different size and different flow rates. These modified instruments have also performed well. (auth)

44840 (HPR–74) EXPERIENCE WITH IN-PILE THERMOCOUPLES AT HBWR. Riley, P. J. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). Apr. 1967. 34p. Dep.

Most in-pile temperature measurements at HBWR have used standard chromel/alumel thermocouples with Inconel sheaths and alumina insulation. Careful in-pile calibrations have shown that the spread of thermocouple corrections is within ±0.5°C and this is unaffected by radiation up to 10^{20} n/cm^2 integrated thermal flux. The overall failure rate has been about 7%. A special technique using electron beam welding was developed for attaching thermocouples to the fuel canning. For measurements of UO_2 fuel temperatures tungsten–rhenium alloy thermocouples with molybdenum sheaths and magnesia insulation have been used.

These were satisfactory for initial measurements up to about 1900°C, but usually have failed early in life. (auth)

44841 (HPR-75) DEVELOPMENT OF AN IN-PILE VOID GAUGE. Schenk, K. (Institutt for Atomenergi, Halden (Norway). OECD Halden Reaktor Prosjekt). May 1967. 21p. Dep.

A void gauge which dynamically measures exit void fractions in fuel assembly channels, has been developed and successfully used in-core at the Halden Heavy Water Boiling Reactor. The present void gauge design does not require a metal-to-ceramic seal at the coax cable end. The design of the new instrument is presented and performance data of void gauge types are given. (auth)

44842 (IDO-17238) DIRECT RADIATION LEVELS DURING LOFT OPERATION AND FOLLOWING THE LOSS-OF-COOLANT TEST. Warkentin, J. K. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 1967. Contract AT(10-1)-205. 55p. Dep. CFSTI.

The results of various analyses to determine the direct radiation levels which may be expected in association with LOFT reactor operation and the loss-of-coolant experiment are presented. The reactor package and containment building are briefly described with regard to the aspects pertinent to the analysis. Calculated gamma dose rates are presented as a function of distance inside and outside the containment building during full-power operation, as a function of distance inside the containment building for decay times ranging from 10^3 to 10^6 seconds following normal shutdown after 400 hours of operation, and for various locations inside the containment building and as a function of distance outside the building for decay times ranging from 10^3 to 10^6 seconds following the loss-of-coolant test. Integrated gamma doses are given for various locations inside the building and as a function of distance outside the building for various periods of reactor operation, and for decay periods of one day and five days following the loss-of-coolant test. Calculational techniques are presented in the Appendix. (20 references.) (auth)

44843 (IDO-17239) STEP PROJECT. Quarterly Technical Report, January 1-March 31, 1967. Dietz, K. A. (ed.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Aug. 1967. Contract AT(10-1)-205. 155p. Dep. CFSTI.

REACTOR SAFETY EXPERIMENTS—reactor vessel for LOFT, nil-ductility transition temperature calculation for; blowdown analysis of LOFT, calculation of transient hydraulic forces on reactor loop components for; coolant loss from LOFT reactor, total fission product gamma dose after; blowdown testing using simulated LOFT core, semiscale
PRESSURE VESSELS—hydrogen combustion in LOFT, calculation of; failure time as a function of degree of core disassembly, determination
REACTOR CONTROL ELEMENTS—heating rates in LOFT cruciform, calculation and measurement of
REACTORS POWER—coolant losses in, bottom-head melt-through analysis for; core spray systems for, experimental evaluation of; design of LOFT; gamma radiation from LOFT, measurement of total direct; radiation levels in, analytical techniques and equations for determining
REACTORS, WATER-COOLED—coolant losses in, bottom-head melt-through analysis for; core spray systems for, experimental evaluation of; design of LOFT; gamma radiation from LOFT, measurement of total direct; radiation levels in, analytical techniques and equations for determining
REACTOR SAFETY—reactor core spray systems for, experimental evaluation of
REACTORS, WATER-MODERATED—design of LOFT; gamma radiation from LOFT, measurement of total direct; radiation levels in, analytical techniques and equations for determining
FISSION PRODUCTS—inventory after LOFT reactor full power operation; release in LOFT, calculation and measurement of, for LOFT; deposition on heated and cooled surfaces; monitor for, performance of LOFT continuous sampler
COATINGS—behavior for LOFT of removable
IODINE—removal from LOFT containment system
REACTORS, PRESSURIZED-WATER—coolant loop failure in, model for calculating subcooled decompression during
REACTOR SIMULATORS—coolant loss accident simulation for LOFT system, use of analog system for
NEUTRONS, THERMAL—flux measurements during LOFT full power operation (M.L.S.)

44844 (IN-1107) MACABRE II. Griebenow, M. L.; Richert, K. D. (Idaho Nuclear Corp., Idaho Falls). Sept. 1967. Contract AT(10-1)-1230. 86p. Dep. CFSTI.

MACABRE II was written for the IBM 7040 computer in use at the NRTS. The basic programming language is FORTRAN IV, but some symbolic routines are used in the 7040 version. A version that is programmed in FORTRAN IV for the Univac 1108 is also available. This version contains small symbolic routines for the date, time, and auxiliary storage definitions, and should present no problems in conversion to another computer. MACABRE II is capable of solving the isothermal hydraulics and nonisothermal hydraulics and heat transfer of most plate-type reactor fuel assemblies cooled by a subcooled fluid in forced convection. It can accommodate two-dimensional, time-dependent (quasi steady state) heat generation rates and hydraulic communication between the parallel coolant channels. In addition, MACABRE II will compute the corrosion of the aluminum-clad heat-transfer surfaces (when present) and can handle partial sloughing of the Boehmite corrosion product. MACABRE II has been employed in MTR, ETR, ATR, and EOCR fuel assembly analysis. (auth)

44845 (IN-1112) CHARACTERIZATION OF THE FRACTURE SURFACE OF THE PM-2A PRESSURE VESSEL. Zelezny, W. F.; Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). Aug. 1967. Contract AT(10-1)-1230. 26p. Dep. CFSTI.

The PM-2A pressure vessel, which in service had received a fluence of the order of 10^{19} neutrons/cm^2, was tested in a controlled fracture mechanics program with the intent of producing a brittle failure. The destructive test condition of -20°F insured that the failure took place well below the NDT temperature of the irradiated A350-LF3 steel. The resulting fracture originated in an elongated artificial defect and extended axially along the cylindrical wall of the pressure vessel from both ends of the defect. A 21 inch length of fracture surface, including the artificial defect, was obtained for the purpose of characterizing the fracture and estimating the percentage of brittle fracture by over all macro-observation of the fracture appearance, by electron fractography, and by examination of the microstructure of the adjacent material to determine composition, grain size, and inclusion frequency or soundness. Four distinct regions were observed, namely: a shear lip in the A350-LF3 steel along the outside edge of the pressure vessel, the fracture through the 304 stainless steel weld deposit which formed a liner for the vessel, the stress corrosion region which started at the tip of the artificial defect and extended an appreciable distance into the A350-LF3 steel, and the rapid running fracture which comprised the major portion of the fracture surface in the A350-LF3 steel. Extensive dimpling in the shear lip and in the 304 stainless steel liner indicated the fracture was ductile in these regions. A stress corrosion region at the base of the artificial defect was surprisingly deep and showed mostly corrosion products with few clear cut indications of cleavage planes. Fractographs from the region of the rapid running fracture, regardless of whether at the fracture origin or at points at varying distances from the origin, showed principally quasi-cleavage. This extensive quasi-cleavage and the overall macro-observations led to an estimate of at least 90% brittle fracture for the rapid running fracture. (auth)

44846 (KFK-564) HERSTELLUNG VON BRENNELEMENTEN ZUR BESTRAHLUNG IM EFFBR. TEIL I. BRENNSTOFFHERSTELLUNG. (Production of Fuel Elements for Irradiation in EFFBR. Part I. Fuel Production). Dippel, Th.; Walther, K. H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Mar. 1967. 8p. (In German). Dep.

The preparation and production for fast reactor fuel element fabrication is presented. Preparation procedures are outlined; chemical processing for the fuel material is discussed. A materials balance for the production process is given. (M.L.S.)

44847 (KFK-613) SAFETY ASPECTS OF STEAM COOLED FAST BREEDER REACTORS. Frisch, W.; Heller, F.; Huebschmann, W.; Malang, S.; Mueller, A.; Schikarski, W.; Smidt, D.; Wotte, G. (Kernforschungszentrum, Karlsruhe (West Germany)). June 1967. 29p. Dep.

Results on the dynamic and safety analysis of the first German 1000 MWe steam cooled fast breeder reactor design (D1) are presented. Problems can be solved from boiling water reactor technology. The special results of the investigations will be useful in the determination of new steam cooled fast reactor concepts. (auth)

44848 (LA-3724) FAST REACTOR DESIGN COMPUTATIONS. Mills, Carroll B. (Los Alamos Scientific Lab., N. Mex.). June 1967. Contract W-7405-eng-36. 72p. Dep. CFSTI.

Neutron physics studies of the existing wide variety of nuclear power systems are best accomplished with fast computing machines because of the large mass of cross-section data to be processed and the complexity of neutron transport in energy and space. Solution of the neutron transport and absorption problem involves a Master Data Tape from which properly averaged neutron cross sections must be obtained for the integration of the S_n neutron conservation equations. In addition, the neutron cross sections

must be modified for different reactors and the system of calculation must be validated by reactivity correlations. Finally, the characteristics of the reactors of interest may be computed. Codes written to do these things are briefly described, and a study of fast breeder reactors illustrates the applicability of the entire system of computing. (auth)

44849 (LA-3734) TRANSFER FUNCTIONS FOR CIRCULATING-FUEL REACTORS. Henderson, B. J.; Ragan, G. L. (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 16p. Dep. CFSTI.

The zero-power transfer function, the power feedback transfer function, and the total reactor transfer function have been determined analytically for a direct-contact, circulating-fuel reactor. Decay and extraction of delayed neutron precursors in the loop outside the core, and the variation of the coolant temperature in this loop are considered. A FORTRAN-II program has been coded for the IBM 704, and graphs present the results of some parametric studies. The analytic expressions are applicable to circulating-fuel reactors in general, but the parameter values used in the studies reported here are based on conceptual direct-contact reactor designs. (auth)

44850 (NYO-3530-2) STUDY OF ECONOMIC FEASIBILITY OF FAST BREEDER REACTOR PROTOTYPE IN NEW ENGLAND AREA. VOLUME II. GENERAL SITE SURVEY FOR NUCLEAR PLANTS IN THE NEW ENGLAND AREA. (Jackson and Moreland, Boston, Mass.). Aug. 18, 1967. Contract AT(30-1)-3530. 128p. Dep. CFSTI.

For Holyoke Water Power Co., Mass.

A feasibility study of the general suitability of the New England area for installation of nuclear power plants is presented. The Holyoke Water Power Company's Mt. Tom site for installation of a fast breeder prototype is evaluated. Health hazards, seismic activity, availability of coolant supply, proximity to load centers, and geologic factors are considered. (81 references.) (M.L.S.)

44851 (ORNL-P-3158) DISCRETE ORDINATE TRANSPORT THEORY CALCULATIONS OF THE EFFECT OF HETEROGENEITIES ON REACTIVITY IN ZPR-3 ASSEMBLY 48. Edison, G. E.; Bennett, L. L. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 8p. (CONF-671102-1). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

Effects of heterogeneities in fast critical assemblies are calculated using multigroup iterative fission source discrete ordinate cell calculations. Up to 32 angular intervals were used with a double Gaussian angular quadrature and with a modified single Gaussian quadrature, as well as the single Gaussian quadrature. An iterative discrete-ordinates J_n computer code was used for calculations. Results obtained with different angular quadratures are compared on a basis of solutions having equal numbers of discrete angles. 11 references. (M.L.S.)

44852 (ORNL-TM-1911) REMOVAL OF ELEMENTAL IODINE FROM STEAM-AIR ATMOSPHERES BY REACTIVE SPRAYS. Parsly, L. F. Jr. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 36p. Dep. CFSTI.

A computer program for calculating mass transfer rates for removal of I_2 from steam–air atmospheres by reactive sprays is given. Included are procedures for calculating the transport properties revealed in the mass transfer rate calculations. The calculations predict half-lives for I_2 removal of 30 seconds or less, indicating that an effective spray system can prevent the leakage of I_2 from a containment building. The removal half-lives are not greatly affected by temperature up to 150°C. 12 references. (auth)

44853 (ORNL-TM-1979) COMPARATIVE EVALUATION OF SOL-GEL FUEL FABRICATION COSTS. Washburn, T. N.; Lotts, A. L.; Harrington, F. E. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 55p. (CONF-671008-2). Dep. CFSTI.

From Symposium on Sol-Gel Processes for the Production of Ceramic Nuclear Fuels, Turin, Italy.

Estimates were made of the costs of fuel preparation and fabrication of sol-gel metal-clad $(U,Pu)O_2$ fuel elements. Four processes were compared, and their costs, including hardware, were: low-energy packing of microspheres, $331/kg; vibratory compaction, $337/kg; pelletizing, $342/kg; and sol-gel extrusion, $331/kg for 0.220-in.-dia UO_2-18% PuO_2. These costs include only the plant operating expenses and capital charges at a fixed annual rate of 22%. The hypothetical plant produces 500 kg of core fuel per day to support a fast reactor industry of 15,000 MW(e). Costs of fuel material, fuel losses, inventory, and scrap recovery were not included, since they are the same for all the processes. Projected technology indicates little economic difference among the four processes, and each could be an excellent contender for production of fast reactor fuel. Continued development is needed to define more adequately the technical and economic capabilities and limitations of the four methods. (auth)

44854 (ORNL-TM-1993) EXPERIENCE WITH HIGH-TEMPERATURE CENTRIFUGAL PUMPS IN NUCLEAR REACTORS AND THEIR APPLICATION TO MOLTEN-SALT THERMAL BREEDER REACTORS. Smith, P. G. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 44p. Dep. CFSTI.

Design features, development problems, and operating experience have been compiled for liquid-metal and molten-salt circulating pumps used in various nuclear reactors and test facilities. The compilation was made to search out the problem areas and to select suitable combinations of features for the circulating pumps required by each of the three molten-salt systems in the proposed molten-salt thermal breeder reactor. The pumps are divided into two configurations: the "short-shaft pump" and the "long-shaft pump." The short-shaft pump is favored for the coolant salt system, and the long-shaft pump is favored for the fuel-and-blanket salt systems. (auth)

44855 (PG-Report-790) SOME PRELIMINARY RESULTS AND COMMENTS ON THE USE OF ^{16}N FOR MEASURING CHANNEL OUTLET TEMPERATURE IN GAS COOLED REACTORS. French, R. L. D. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1967. 18p. Dep. CFSTI. UK 2s. 6d.

Measurements made of the ^{16}N activity of the outlet gas of channels in a Calder reactor are presented. The use of such measurements as an aid to detecting channel blockage is examined. The practicability of correcting for ^{16}N decay during transit along the sample-pipe in the Windscale A.G.R. is assessed. Such a correction is probably necessary in order to increase the accuracy of the ^{16}N measurements sufficiently for them to be employed for estimating channel gas outlet temperatures. The effect of ^{16}N adsorption in this context is briefly examined. The measurement of channel temperature using ^{16}N activity could assist the on-power optimization of temperature conditions in Calder type reactors and could also result in savings on future Civil A.G.R.s. Further work is required before the technique could be used in a routine manner on a reactor. (auth)

44856 (RISO-M-514) HEAT PIPE THERMIONIC REACTOR CONCEPT. Pedersen, Erik Storm (Danish Atomic Energy Commission, Risoe. Research Establishment). May 1967. 21p. Dep.

A preliminary design study of a heat pipe thermionic reactor concept is described and a possible arrangement of a compact 1 MW thermionic reactor is shown. In the heat pipe thermionic reactor concept thermal power generated in the reactor core is transported by heat pipes to thermionic diodes located outside the reactor core. The thermionic emitters are in direct contact with the outside envelope of the heat pipes and the collectors are in contact with a liquid metal cooling system that transfers the waste heat to a radiator. The heat pipe uses the heat of vaporization and capillary action of a fluid to transport thermal energy at a high efficiency and a constant temperature along the entire heat pipe. It is therefore possible to obtain in-pile temperatures outside the core and thereby avoiding most of the problems associated with the in-pile thermionic designs, such as: change of emitter dimensions due to fuel swelling upon irradiation; interaction between emitter and fuel; fission product contamination of the interelectrode space charge material; and the effect of nonuniform reactor power generation of the performance of the thermionic diodes. (auth)

44857 (SWRI-1228P9-13) THE SECOND INSPECTION OF THE ELK RIVER REACTOR PRESSURE VESSEL AFTER OPERATION. Norris, E. B.; Ireland, D. R.; Lautzenheiser, C. E. (Southwest Research Inst., San Antonio, Tex.). July 21, 1967. Contract AT(11-1)-1228. 50p. Dep. CFSTI.

The Elk River Reactor pressure vessel was inspected after the reactor had been operated for approximately 2 full-power years. Inspection procedures, similar to those used during the previous (1966) inspection, are discussed. No cracks were found in nozzles in the shell or head and top head overlays. Cracking found in the shell flange overlay during the 1966 inspection has not increased, and again it was concluded that they did not penetrate into the base steel. During the postoperational period, the shell flange overlay was coated with an unidentified substance that significantly impairs liquid penetrant inspection. An ultrasonic inspection of the vessel flange was made to determine if the cladding cracks had penetrated into the base steel. The observations confirmed the results of the patch grinding inspection. (auth)

44858 (SWRI-1228P9-14) INSPECTION OF BORON CARBIDE REGULATING AND CONTROL RODS IN THE ELK RIVER REACTOR. Norris, E. B.; Ireland, D. R. (Southwest Research

Inst., San Antonio, Tex.). Aug. 4, 1967. Contract AT(11-1)-1228. 16p. Dep. CFSTI.

The inspection of three B_4C control rods that had been installed during the 1966 outage of the Elk River Reactor is described. Borescopic inspection of these control rods revealed that what appeared to be holes in the Inconel 600-clad B_4C poison tubes were shadows caused by a loose deposit, possibly a corrosion product. A small sample of the deposit was obtained and is being retained. The control rods appeared to be structurally adequate for continued service. (auth)

44859 (TID-24031) DIGITAL COMPUTER BLOWDOWN ANALYSIS FOR LOSS-OF-FLUID TEST FACILITY. PART 1. ENGINEERING. Fabic, Stanislav (Kaiser Engineers, Oakland, Calif.). May 1965. Contract AT(10-1)-1165. 73p. Dep. CFSTI.

This computer program applies to blowdown of the pressurized water reactor primary coolant loops. The loop contains a reactor, pump, check valve, heat exchanger, and pressurizer. One-dimensional and transient mass balance, force balance, and energy balance equations, for both the fluid and the wetted walls, are solved numerically, using the first-order differences in both time and space. The compressibility of the fluid, due to a change in phase from liquid to steam, is included, as well as the local heat transfer from the walls. Fauske's critical flow relation is made to apply at the rupture, and Schrock and Grossman's two-phase pressure drop correlation is incorporated in the force balance equation. Steam tables, coded in function form, provide the equations of state for the two-phase; thermodynamic equilibrium is assumed to apply during blowdown. Three levels of iterations are employed during the numerical solution. The first level includes simultaneous solution of the three (non-linear) balance equations and of the equations of state for each spatial segment of the loop. The second iteration level adjusts the flows at the branch where the two loop legs and the leg leading to the rupture meet, to satisfy the branch boundary conditions. The third iteration level adjusts the flow through the rupture to meet the exit boundary conditions and the initial conditions for the loop. Convergence was obtained only when the conditions were limited to preclude any flow direction reversals and to neglect the fluid inertia. Consequently, the computer program, in its present form, applies to the following cases: complete blowdown of initially saturated liquid through small ruptures (less than about six inches in equivalent diameter); part of blowdown through larger ruptures when the flow of fluid in the loop, towards the rupture, has already been established. The earlier part of blowdown can be computed, but since inertia effects are disregarded, the computed results are in error. A separate, so-called water-hammer program is used to account for the initial acceleration of the fluids, and the results of the two programs are merged. 31 references. (auth)

44860 (UJV-1828) KOMPENSACE OTRAVY ABSORBUJICIMI PRVKY ROZPUSTENYMI V MODERATORU. (Poison Compensation by Absorbers Solved in the Moderator). Pernica, R. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 37p. (In Czech). Dep.

A physical method of the calculation is described for the compensation of an equilibrium poisoning by the absorber solved in the moderator in a one-zone core. The time schedule of ion exchanger application and absorber dosing into the moderator is determined to keep the desired absorber concentration during reactor startup. The variations of the reactor temperature coefficient are treated, which are due to absorber solved in the moderator. A numerical calculation is carried out considering an equalized neutron flux for the case of a stepwise increase of the reactor power during startup. (auth)

44861 (WCAP-3269-20) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, October 1-December 31, 1966. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3269. 22p. Dep. CFSTI.

Oxide thickness on Zircaloy cladding materials is shown as a function of exposure time. Radiation effects on advanced fuel assembly prototypes irradiated in Saxton Power Reactor are discussed. Fuel swelling studies are presented. (M.L.S.)

44862 (WCAP-3269-21) LARGE CLOSED-CYCLE WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Progress Report, January 1-March 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Contract AT(30-1)-3269. 13p. Dep. CFSTI.

Results of corrosion tests of Zircaloy cladding materials are tabulated as a function of bulk water temperature. A list of 69 references concerning water reactor research and development is presented. (M.L.S.)

44863 (JPRS-42155) DETERMINING THE PRICE OF PLUTONIUM USED AS A NUCLEAR FUEL. Kazachkovskii, O. D.; Kirillov, E. V. Translated from At. Energ. (USSR), 22: 439-44(June 1967). 11p. (TT-67-32785). CFSTI.

The economics of using Pu as a secondary nuclear fuel are discussed. The price of Pu is determined for thermal and fast reactors. Comparisons of economic advantages in using Pu and U fuels are presented. (M.L.S.)

44864 CALCULATIONS OF NON-LINEAR THERMAL CONDUCTIVITY IN FUEL ELEMENTS HEATED BY ELECTRIC CURRENT WHOSE ELECTROCONDUCTIVITY IS A FUNCTION OF TEMPERATURE. Furman, A. V.; Ivanov, V. V. (Tomsk Polytechnic Inst., USSR). Teplofiz. Vys. Temp., 5: 718-20 (July-Aug. 1967). (In Russian).

A non-stationary temperature field in a fuel element (during start-up, pulsation etc.) was studied in the case in which the thermal and electric conductivity and specific heat of the substance are functions of temperature. The alterations of electric conductivity in heated fuel elements cause redistribution of current density and thermal skin effect. Electrical current heating of $\delta = 2$ mm thick highly alloyed austenite type steel plate was calculated. An exponential approximation of dimensionless magnitudes of specific heat and heat conductivity at $0 \leq t \leq 420°C$ are equal to: $C \approx 1.0024\ (0.4800 \times 10^{-3}\ t)$, $L \approx 1.0116 \exp\ (0.8678 \times 10^{-3}\ t)$ (where $C = 1 + 0.53$ and $L = 1 + 1.06$). Temperature values on the plate axis were compared and tabulated. (R.V.J.)

44865 DEVELOPMENT OF ZIRCONIUM ALLOY PRESSURE TUBES FOR THE WINFRITH HEATH STEAM GENERATING HEAVY WATER REACTOR. Watkins, B.; Cockaday, R. E. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Proc. Inst. Mech. Eng. (London), 180: Pt. 3D, 53-63(1965-66).

From Conference on New Engineering Materials, Birmingham, Eng., Oct. 13-14, 1965. See CONF-651089.

The prototype steam generating heavy water moderated reactor incorporates Zircaloy-2 pressure tubes 0.2 in. thick, 5.14 in. internal diameter and 15 ft long to a straightness tolerance of 1/3000, and Zr-2½% Nb alloy tubes 0.12 in. thick. Work leading to the successful manufacture of such tubes is described. Mechanical properties, both at room and the design temperature of 300°C, were evaluated to confirm the preliminary choice of design stress, and appropriate corrosion testing led to the definition of corrosion allowances. Additionally, attention was paid to the details of the manufacturing process which can affect those properties that influence economic tube operating life. During service, hydrogen is absorbed by the pressure tube from the corrosion reaction, and this can affect mechanical properties. The magnitude of this effect is dependent on hydrogen content, distribution, and morphology. Irradiation also affects mechanical properties, and in particular it raises the tensile strength and reduces the energy absorbed in a notch impact test. Investigation of these effects has led to the development of new testing techniques to assess the consequences of hydrogen and irradiation on tube life. This development, and the implications of the test results, are discussed in the paper. In the case of the Zr-2½% Nb alloy, an ultimate tensile strength at 300°C in excess of 90,000 lb/in.^{2} can be obtained by water quenching from 850°C and subsequently tempering at 500°C, but this heat treatment has had to be optimized to give a balance between the strength and corrosion requirements. The experimental work leading to the optimization of the heat treatment is described and the properties of full-sized pressure tubes detailed. (auth)

44866 OBRIGHEIM: EUROPE'S 300 MW PWR. Eng. Boiler House Rev., 82: 228-30(Aug. 1967).

A brief description is presented of the Obrigheim power station, which is being erected by Siemens AG, and is due for commission in 1968. (UK)

44867 DETERMINATION OF NEUTRON MULTIPLICATION. I. CONCEPT. Kaneko, Yoshihiko (Japan Atomic Energy Research Inst., Tokyo); Sumita, Kenji. J. Nucl. Sci. Technol. (Tokyo), 4: 400-7(Aug. 1967).

In a highly subcritical system with reflector, it is demonstrated that none of the methods so far developed serves usefully in accurately determining the value of the multiplication factor, and that the fundamental difference between the essential properties of the prompt and the delayed neutron modes makes it extremely difficult to develop a new method to fulfill this need. Based on this judgment, it is proposed to abandon the widely used concept of multiplication factor, and to look for a new concept to represent the state of neutron multiplication, in the case of reflected highly subcritical systems. A new concept is presented in which a fundamental prompt neutron decay constant α_{000} is adopted to measure the neutron multiplication, this constant being of such

nature as to satisfy the following two fundamental conditions. It is uniquely measurable free from spatial and energetic dependence, and it is amenable to direct calculation from the fundamental equation for neutron transportation. (auth)

44868 ALBEDO COMPONENT OF GAMMA-RAY STREAMING THROUGH STRAIGHT CYLINDRICAL DUCTS. Miyakoshi, Jun-ichi (Hitachi Zosen, Ltd., Osaka); Miyasaka, Shun-ichi; Tsuruo, Akira. J. Nucl. Sci. Technol. (Tokyo), 4: 423-6(Aug. 1967).

An experimental study was performed to investigate the effect of γ-ray streaming through cylindrical steel and lead ducts having various lengths and radii. ^{60}Co and ^{137}Cs point sources, and a small sized detector (pulse dosimeter with plastic scintillator) were adopted, source and detector being located at the centers of opposite duct mouths. The albedo-to-direct component ratio is about 30% for steel ducts and 10% for lead at γ-ray energies of 1.25 and 0.661 MeV, with $L/R_0 \sim 10$. The measured results were compared with those calculated by the Monte Carlo method; they showed a good agreement. Consequently, the prediction of doses for straight cylindrical ducts having various length to-radius ratios can be made by the procedures based on the Monte Carlo calculations. (auth)

44869 SEMI-EMPIRICAL FORMULAS FOR MICROPARAMETERS δ^{25}, δ^{28}, ρ^{28} IN WATER MODERATED SLIGHTLY ENRICHED URANIUM AND URANIUM OXIDE LATTICES. Yamamoto, Hisashi, Fujii, Masaaki (Hitachi Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 415-22(Aug. 1967).

A linear relationship between the reciprocals of microparameters such as δ^{25}, δ^{28}, ρ^{28} and effective moderator to fuel volume ratios was found to exist. Based on this relationship, semi-empirical formulas for the microparameters were derived, in a form represented by $\delta^{25} = [C_1^{25}g(\omega)/f\cdot(W/U) + B^{25}]$ where C's and B's are constants empirically determined, $f\cdot(W/U)$ the effective moderator to fuel volume ratio, and $g(\omega)$ a function depending on fuel enrichment. These semi-empirical formulas can reproduce experimental data more effectively than conventional theoretical calculations. (auth)

44870 VALUE OF Pu AS NUCLEAR FUEL. Kazachkovskii, O. D.; Kirillov, E. V. At. Energ. (USSR), 22: 439-44(June 1967). (In Russian).

The question of the value of Pu used as a secondary nuclear fuel was examined. Under conditions of equality of the fuel composition for Pu and U fuels during the production of electroenergy from the same reactor, the cost of Pu was determined for thermal and fast reactors. Conclusions were drawn on the economic advantages of the use of Pu and U as a function of the type of reactor. Cases for the development of nuclear power plants, showing the effects on the development of the cost of Pu developed in reactors, were examined. (tr-auth)

44871 SYSTEM EFFECTIVENESS CALCULATION OF PARTIALLY IMMERSED CONTROL RODS. Chermak, I. At. Energ. (USSR), 22: 492(June 1967). (In Russian).

A study of the effectiveness of partially immersed control rods with a nonsymmetrical arrangement in a cylindrical reactor both with and without a reflector is presented. The proposed method is also applicable for determining the distribution of thermal and moderated neutrons near the control rods or at any point in the reactor. The method is based on the following assumptions: the neutron density can be distributed in a series in respect to the axial characteristic functions; the extrapolation length of the partially immersed control rod or the hollow channel is equal to the corresponding length of an infinite rod or a channel. Calculations were made for a homogeneous reactor 215 cm in diameter and 415 cm high. (ATD)

44872 ^{233}U FAST BREEDER. Mills, Caroll B. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl., 3: 589(Oct. 1967). (LA-DC-8929).

Comparison of breeding gain for fast ^{232}Th-to-^{233}U breeder reactors and ^{238}U-to-^{239}Pu breeder reactors includes: producing narrow-energy-group-averaged cross sections, including anisotropic scattering effects, covering the flux spectra of interest; using the cross sections to compute the critical constants and material reactivity of a number of elements in several clean, critical experiments to establish the quantitative value of cross sections; and computing breeding gain of the ^{233}U and ^{239}Pu breeder reactors for several ratios of carbon atoms to fertile atoms. The results in terms of net gain in fuel or daughter atoms (^{233}U or ^{239}Pu) in the reactor for each fertile or parent atom (^{232}Th or ^{238}U) lost by fission are presented. (D.C.C.)

44873 ANALYTICAL STUDY OF THE DYNAMIC BEHAVIOR OF THE SELF-CONTROLLED MARVIKEN BOILING HEAVY-WATER REACTOR. Reisch, Frigyes; Spanne, Torsten (Aktiebolaget Atomenergi, Stockholm). Nucl. Appl., 3: 590-8(Oct. 1967).

The quantitative influence of the void and Doppler coefficients on the dynamics of the Boiling Heavy-Water Reactor (BHWR) under different operating conditions has been examined. Owing to the difficulty of calculating these coefficients exactly and their great influence on the dynamic behavior of the self-controlled reactor, these parameters have been studied over a wide range. The studies also improve understanding of the transient behavior of the BHWR concept. It has been found that undamped oscillations can arise with special combinations of the reactivity coefficients. In the nonlinear dynamic model used, the void reactivity contribution comes from the changes of the exit void and the subcooling. The oscillations induced by the reactivity feedbacks have different dampings and frequencies of $\approx$0.003 or $\approx$0.03 cps, depending on the sign and the magnitude of the void reactivity coefficients. The transient neutron flux responses to step reactivity perturbations that have the first peak (limited by the fuel Doppler coefficient) as the largest overshoot or that are strongly damped oscillations lie in a well definable area in the exit void and subcooling reactivity coefficient coordinate system. Disturbances introduced by reactivity variation and main steam-valve opening are discussed. The transient responses calculated were those of the neutron flux, reactivity, pressure, moderator temperature, exit void, average void, subcooling, and temperatures of the boiler and superheater fuel. (auth)

44874 COATED-PARTICLE FUELS IN HIGH-TEMPERATURE REACTORS: A SUMMARY OF CURRENT APPLICATIONS. Goeddel, W. V. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract AT(04-3)-167. Nucl. Appl., 3: 599-614(Oct. 1967). (GA-7650).

Coated-particle fuels have been adopted for all of the current and proposed high-temperature gas-cooled thermal reactors: the General Atomic High-Temperature Gas-Cooled Reactor (HTGR), the OECD DRAGON Reactor Experiment, the German pebble-bed reactors (AVR and THTR), and the Ultra-High-Temperature Reactor Experiment (UHTREX) of the Los Alamos Scientific Laboratory. In addition, coated-particle fuel is being considered for the British Advanced Gas-Cooled Reactor (AGR) in order to achieve higher fuel-surface temperatures. The design and operational characteristics of these reactors are summarized, and detailed descriptions and illustrations of their fuel elements, fuel compacts, and coated-particle fuel are presented. A comprehensive list of references is given for each reactor and its fuel. (auth)

44875 ELECTROHYDRAULIC CONTROL ROD SAFETY SYSTEM FOR SM-2 REACTOR. Gorshkov, S. I.; Gromov, L. F.; Ionaitis, R. R.; Shchegoleva, E. K. At. Energ. (USSR), 22: 234-5(Mar. 1967). (In Russian).

An electrohydraulic safety rod is described. The absorber rod is held in its extreme upper position by an electromagnet. The safety rod is driven into the reactor by cutting off the electromagnet. The rod is removed from the reactor hydraulically by a piston which resets the control rod in its upper position. The liquid flow required to raise the rod at a rate of 0.01 m/sec over its entire length of 0.38 m was 2.3 m^3/hr. The time to raise the rod was 1.5 to 5 sec. The time to drive the rod into the reactor was 0.22 to 0.25 sec. The control system was found to be reliable in operation, compact, simple and cheap. Hence, it is suitable for use by other reactors. (TTT)

44876 THE FAST-FISSION EFFECT IN LATTICES CONSISTING OF CLUSTERED ELEMENTS. Rognon, Jacques (Eidgenossisches Institut fuer Reaktorforschung, Wurenlingen, Switzerland). Nucl. Sci. Eng., 30: 109-21(Oct. 1967).

Fast-fission effects in lattices with cluster elements are treated by dividing the cluster into concentric annuli and homogenizing each ring by means of the subcell method. Each annular zone is analyzed separately, and the influence of neighboring zones is described by in- and out-currents at the zone boundaries. Consistency of cross sections is checked in the simple case of an isolated rod in air. Backscattering and cluster-cluster interaction effects are taken into account and an extensive comparison is made between theoretical and experimental fission ratios. Finally, a new definition of ϵ is proposed, which is more consistent with the definition of p and combines all fast events in ϵ. EPSICH calculates a complete case in a few tenths of a second on a CDC-1604, which justifies its use for optimalization studies. (auth)

44877 THERMAL DISADVANTAGE FACTORS AND FAST ADVANTAGE FACTORS IN URANIUM–THORIUM, SEED-BLANKET ASSEMBLIES. Glickstein, S. S.; Lehmann, P. H.; Wheat, L. L.; Korsmeyer, J. D.; Milani, S.; Smith, G. G.; Weiss, S. H. (Bettis Atomic Power Lab., West Mifflin, Penn.). Con-

tract AT(11-1)-Gen-14. Nucl. Sci. Eng., 30: 122-36(Oct. 1967). (WAPD-T-1887).

Thermal disadvantage factor measurements in cells of seed-blanket assemblies containing highly enriched ^{235}U and ^{233}U fuel rods as well as in cells containing slightly enriched ^{233}U fuel rods are in agreement within experimental uncertainties with calculations for all but a very tightly packed blanket lattice. The measurements were corrected for flux perturbations in the fuel rod and the moderator channel caused by the detecting foils. MARC calculations using the Radkowsky scattering kernel yield results approximately 8% higher than similar calculations using the Nelkin kernel. While THERMOS calculations for the tightly packed blanket cells appear to be in agreement with measurement (possibly fortuitous), MARC results are significantly above the measured values. The source of the discrepancy is not known at this time. Higher order scattering as well as angular energy effects in the source-to-thermal neutron energy treatment have been investigated using a newly developed full energy range (0 to 10 MeV) Monte Carlo program RECAP-4C. (auth)

44878 NEUTRON LEAKAGE EFFECTS ON THE FAST ADVANTAGE FACTOR IN A SEED-BLANKET ASSEMBLY. Glickstein, S. S.; Beck, J. W.; Wheat, L. L.; Hall, W. J. (Bettis Atomic Power Lab., West Mifflin, Penn.). Nucl. Sci. Eng., 30: 137-43(Oct. 1967).

Fast advantage factor measurements and calculations have been performed in a single module seed blanket assembly containing a ThO_2 blanket and a highly enriched U seed. Large variations were noted in the advantage factors, which were attributed to leakage effects due to the narrow seed region and the varying fast-neutron source distribution through the core. One-group, two-dimensional Monte Carlo calculations with the MARC program approximating the explicit core geometry are in agreement with the measured results. Calculations were also performed applying the principles of superposition and reciprocity to illustrate the dependence of the fast advantage factor on neutrons originating from various sections of a core. (auth)

44879 EFFECTS OF MODERATOR TEMPERATURE GRADIENTS ON THERMAL-NEUTRON FLUX. Williams, Michael D. (Univ. of California, Los Alamos, N. Mex.); Hicks, Thomas E. Contract W-7405-eng-36. Nucl. Sci. Eng., 30: 147-50(Oct. 1967). (LA-DC-8418).

Systems were composed of one or more identical cells with each cell made up of two regions: a fueled region with no moderator present, and a moderator region with a temperature gradient across it. Results of temperature gradients in the moderator are presented for thermal neutron flux variations. (auth)

44880 POWER REACTOR CHARACTERISTICS AND THEIR RELATION TO NUCLEAR ENERGY AS A LONG-TERM RESOURCE IN WESTERN EUROPE. Boxer, L. W. OECD (Organ. Econ. Coop. Develop.) Observ., No. 26, 8-9(Feb. 1967).

Some potential problems which could arise from the development of nuclear power as a major source of energy were examined. A joint examination of questions such as available reserves of nuclear fuels, forecasts of total energy demand, and the characteristics of various reactor systems, to provide a framework for future regional studies to be carried out on a national basis, was sponsored by ENEA. An authoritative estimate by a team of international experts of world reserves of U and Th is presented. The current world surplus of U, coupled with the lack of experience of Th as a large-scale source of energy, does not encourage the further prospecting necessary to establish the true position on low cost fuel reserves. Opinions were divided on the types of reactor and the scale of effort for future development programs, and also on the timing and the degree to which the conservation of nuclear fuel supplies will be an economic and physical necessity. The second report dealt with power reactor characteristics, in terms of a general re-evaluation of the available means of expanding the application of nuclear power to electricity production. The characteristics of 5 types of power reactors (gas-cooled, light water, heavy water, fast breeders, and liquid fueled) were summarized in terms of their relative economy in the utilization of U. (BBB)

44881 NUCLEAR POWER GENERATION IN JAPAN. Takeda, Eiichi (Inst. of Technology, Tokyo). Nenryo Kyokai-Shi, 46: 79-83(Feb. 1967). (In Japanese).

Since the first nuclear power generation of 5 megawatts was started at the Japan Atomic Energy Institute in October 1963, its development work has been growing steadily to make a plan for the installation of a power station with a capacity of 600 to 700 MW. It is anticipated that in ten years one-third of an increasing electricity will be shared by the nuclear power. It is estimated that cost of electricity produced will be 2 yen/kWh with a power station capacity of 600 MW, which is economically competitive with thermal (oil) power at that time in our country. The principle of nuclear power generation together with its safety problems are explained. The present atomic industry in this country is greatly dependent on the techniques developed in foreign countries. However, in view of the fact that the nuclear power generation is coming into practical use, the emphasis is on Japanese production of power plants as well as the development of new type reactors. Fast reactors should be progressed enough to establish Japan's own nuclear industry. (auth)

44882 CHARACTERISTICS OF THE AEROSOL PRODUCED FROM BURNING SODIUM AND PLUTONIUM. Ettinger, Harry J.; Moss, William D.; Busey, Harold (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng., 30: 1-13(Oct. 1967).

Safety analysis of Na-cooled Pu-fueled fast reactor plants must be concerned with the possibility of fires involving these materials. Design of an air cleaning system for such a facility requires basic data defining the aerosol characteristics of Na and Pu released during a fire. Size characteristics of the aerosol produced during Na and Pu fires were determined for different atmospheres ranging from 20.8% O_2 and 79.2 to 100% N_2. The aerosol produced by burning gram quantities of Na was compared with that produced by a fire involving 600 lb of Na. Na aerosol count median diameter ranged from 0.07 to 1.09 μ and was independent of O_2 concentration. Small and large scale fires produced an aerosol with comparable size characteristics. Pu aerosol count median diameter ranged from 0.02 to 0.09 μ and was also independent of O_2 concentration. When Pu alloy was burned under reduced O_2 conditions, the fraction airborne ranged from 2×10^{-7} to 4×10^{-4}. Fires involving Pu alloy and Na together produced airborne Pu–Na ratios ranging from 0.34 to 0.008%. (auth)

44883 PROGRESS AT WORLD'S LARGEST NUCLEAR POWER STATION (WYLFA). Steam Heat. Eng., 34: No. 405, 6-9(Aug. 1965).

A description of the Wylfa Nuclear Power Station for proposed 1180 MW operation is presented. The description includes: prestressed concrete pressure vessels; actual station layout; boilers; progress in construction; and auxiliary facilities. (D.C.C.)

44884 METHOD FOR DETERMINING THE OPTIMUM TYPE OF ATOMIC POWER STATION. Haiduc, C. Rev. Roum. Sci. Tech., Ser. Electrotech. Energ., 11: 263-73(1966). (In Russian).

A study of operation economics and efficiency for nuclear power stations is presented. Results show that reactor types in decreasing order of efficient operation include: boiling reactors; pressurized-water reactors; gas-cooled reactors; and CANDU type reactors. (D.C.C.)

44885 STABILITY OF BOILING-WATER REACTORS AND LOOPS. Neal, L. G.; Zivi, S. M. (TRW Systems, Redondo Beach, Calif.). Contract AT(04-3)-372. Nucl. Sci. Eng., 30: 25-38(Oct. 1967).

A comparative study of analytical models for calculating the hydrodynamic stability of natural-circulation boiling systems and experimental data is presented. The models were evaluated by comparing their physical assumptions, the mathematical simplifications, the methods of solving the equations, and, in some cases, their predicting abilities. The predicting abilities of the models were determined by programming them for a digital computer and using the program to predict experimental loop stability. Each model is a statement and solution of the conservation equations for the two-phase and single-phase fluids, derived and applied using essentially the same physical assumptions. In all of the models studied, the dynamics of the instability can be described as linear feedback between flow rate and vapor volume. All the models contain empirical correlations for slip ratio, friction, and heat transfer derived from steady-state data. There are three major differences between the models: the different slip ratio and friction assumptions or correlations, the extent to which distributed parameters are spatially lumped, and the use of linearized small perturbations and computation in the frequency domain, or integration of the differential equations in time with retention of nonlinear effects. The STABLE-3 program by Jones is the most reliable, and predicts the threshold of instability for loop experiments within 20% for about 70% of the tests. The model of Jahnberg is a distant second in predicting loop stability. The application of Jones' FABLE program, which includes the STABLE-3 hydrodynamics in addition to feedback from the reactor kinetics equations, to the EBWR produces a calculated instability threshold in agreement with the reported 120 MW. The important destabilizing mechanism in the EBWR arises from differences between the plate-type and the rod-bundle-type fuel assemblies in the core in their steam void response to power disturbances. These dissimilarities allow the excitation of a hydrodynamic resonance interaction between the regions with the different fuel assemblies that lowers the instability threshold. (auth)

44886 THEORY OF BRANCHING PROCESSES OF NEUTRONS IN A MULTIPLYING MEDIUM. Saito, Keiichi; Taji, Yukichi (Japan Atomic Energy Research Inst., Tokyo). Nucl. Sci. Eng., 30: 54-64(Oct. 1967).

Statistical aspects of neutron transport in low-power reactors are studied from the viewpoint of branching processes. The probability generating function of a neutron population originating from an ancestor neutron is expressed in the form of the factorial moment expansion, and it is shown how a factorial moment is constructed out of the lower-order moments. The form of the factorial moment expansion of the one-ancestor problem is applied to counting statistics in reactors with random sources. The result turns out to be the factorial cumulant expansion of the probability generating function of count number. It is shown that all the higher factorial cumulants are successively constructed out of the lower orders. New adjoint fields are introduced. It is pointed out that analysis of reactor noise depends on two models of introducing extraneous neutrons into the system, i.e., the random source model and the burst-of-neutrons model. (auth)

44887 EIGENFUNCTION ANALYSIS OF NEUTRON-WAVE PROPAGATION IN MODERATING MEDIA. Ohanian, M. J.; Booth, R. S.; Perez, R. B. (Univ. of Florida, Gainesville). Nucl. Sci. Eng., 30: 95-103(Oct. 1967).

Neutron-wave propagation in moderating media is investigated within the framework of the diffusion approximation to the Boltzmann equation, using a realistic scattering model and the eigenfunction expansion method. The eigenfunctions are obtained from the thermalization theory solution to the exponential experiment with their corresponding eigenvalues being the fundamental and higher diffusion lengths of the medium. A discrete energy formulation, Simpson's rule integration scheme, and the Jacobi method of matrix diagonalization are used in the numerical solution to the eigenvalue problem. The dispersion law for graphite, obtained by direct solution of the complex secular determinant, is compared with experimental results. This investigation indicates that high-energy-mode contamination will not seriously affect neutron-wave experiments in graphite in the frequency range where diffusion and thermalization parameters can be obtained. (auth)

44888 CALCULATION METHODS AND RESULTS OF LEAK-RATE TESTINGS ON CONTAINMENT VESSELS OF NUCLEAR POWER PLANTS. Engel, M. Atomkernenergie, 12: 240-8 (1967). (In German).

A method for the calculation of leak-rates for reactor-containment is presented, including a statistical analysis of errors of measurements. The method uses a digital computer-code. Thus it is possible to obtain statistically secured values of the magnitude of the leak-rate, even during test performance. Experimental arrangements and results of the tests are shown for two examples. The error of measurement is essentially smaller than obtained by earlier measurements. (auth)

44889 HYDROELASTIC INSTABILITIES IN FUEL PLATE ELEMENTS. Smissaert, Georges Emiel Henri. University Park, Pa., Pennsylvania State Univ., 1966. 162p.

Thesis.

The study of the hydroelastic instabilities that occur in nuclear-reactor flat-plate fuel elements is presented. These instabilities were investigated both theoretically and experimentally. The main contribution lies in the study and explanation of the flutter phenomenon that occurs in plate assemblies subjected to high coolant flow rates. The development of the hydroelastic instability equations in two-dimensional channels bounded by flexible surfaces is described. The role of clamped edges parallel to the direction of the flow, and the instability phenomenon at the leading edge are discussed in detail. The physical meaning of the Miller's velocity is explained, and the amplification of built-in disturbances by the flow is treated by example. The experimental part of this study consisted in the testing of three plate assemblies with a channel width equal to 4.5 inches, and channel heights equal to 0.0625 inch, 0.125 inch, and 0.250 inch, respectively. The length of the plate was 45 inches, and the assemblies contained 5 plates, 9 plates, and 15 plates, respectively. A flow loop was built which enabled one to subject these assemblies to water flow rates, the maximum of which corresponded to an average channel velocity equal to 3.5 times the Miller's velocity of the assembly. The plates were instrumented with strain gauges, by means of which both static and dynamic deflection measurements could be made. In addition, it was possible to measure the static pressure profiles in three adjacent coolant channels. The experiments indicated that flat plate fuel elements are subjected to a number of hydroelastic instabilities. The theoretical instabilities are: static divergence at the leading edge, static divergence in the plate array, a low-amplitude vibration in the form of traveling waves, and a high-amplitude vibration or flutter. The low-amplitude vibrations were identified as Class B waves, according to the general classification of Brooke Benjamin. The high-amplitude flutter was identified as a vibration phenomenon originating from the coupling of a leading edge instability with the Class B wave instability. (auth)

44890 THERMAL MODELS FOR PREDICTION OF NEUTRON FLUX LEVELS IN REACTORS. Schlenker, Larry Dale. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 53p.

Thesis.

Two analyses for using temperature profiles to predict one group neutron flux levels in nuclear reactors are presented. The investigation described in Part I is concerned with the feasibility of an empirical comparison between temperature in a thermal setting epoxy resin casting and the neutron flux distribution in a geometrically similar bare homogeneous reactor. It is found that the flux distribution in a spherical shape can be matched. Further tests of the radial and axial temperature distributions of right cylinders suggest that the curvature of a bounding surface presents no special problem. The overall accuracy of the results varied with position and had a standard deviation value of about 5%. Continued study is recommended. The investigation described in Part II derives the prediction and design equations for a three dimensional electrically powered thermal model of a reflected heterogeneous reactor. An arbitrary prototype shape and arrangement of control rods is allowed and it is found that the results are valid for a constant electrical driving potential. The possible application of this method for solving flux related problems such as reactor control and determining the optimum cycling procedure for a reactor using continuously mixed fuel elements is discussed. This is the first proposal of a continuously measurable three dimensional model of a reflected heterogeneous reactor and it is recommended that further development be pursued. (auth)

44891 THERMAL DESIGN OF EBR-II PRIMARY TANK COMPONENTS. Bump, T. R.; Monson, H. O. (Argonne National Lab., Ill.). New York, American Society of Mechanical Engineers, 1967, Preprint No. 66-WA/NE-8, 12p., $1.50. (CONF-661102-38). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

This tank for a Na-cooled nuclear reactor has an intricate cover on which equipment requiring precise alignment is mounted. Therefore, the cover has been provided with features for limiting its thermal deformations and stresses. During this effort, versatile "two-node" and "fins-in-series" methods were developed for conducting, without computer, complex two- and three-dimensional thermal analyses. The subsequent thermal behavior of the cover proved to be as predicted. In addition, a baffle to protect the tank wall was designed, and provisions were made to ensure mixing of the bulk Na in the tank. (auth)

44892 ANALOG SIMULATION UTILIZED AS AN AID IN IMPROVING THE SCRAM TRANSIENT OF HANFORD'S N-REACTOR. Leitz, E. E. (General Electric Co., Richland, Wash.). New York, American Society of Mechanical Engineers, 1966, Preprint No. 66-WA/NE-10, 9p., $1.50. (CONF-661102-40). DTIE.

From American Society of Mechanical Engineers, Winter Annual Conference, New York.

The results of analog-simulation studies were successfully applied during initial phases of N-Reactor operation to predict and interpret plant responses to reactor scrams. Controller, instrument and trip settings were confirmed and the necessary adjustments, maintenance, and equipment programs were carried out to optimize plant performance. Effective control of volume and pressure in the primary loop is an important factor in the achievement of desired plant operation. Correlation of primary system responses to the analog-simulation studies showed it was possible to predict dynamic characteristics resulting from spurious transients or component failures. (auth)

44893 PERTURBATION THEORY APPLIED TO A VARIATIONAL ANALOGY BETWEEN REACTOR THEORY AND CLASSICAL MECHANICS. Turley, Richard Eyring. Ames, Iowa, Iowa State Univ. of Science and Tech., 1966. 66p.

Thesis.

An operator-type perturbation method for solving neutron diffusion equations is presented. The method utilizes a hybrid Schroedinger-Heisenberg quantum mechanical transformation method. A Liouville differential operator is constructed using the Hamiltonian density. Another operator is then developed which, in its final form, appears equivalent to a Volterra integral equation of the second kind with the Liouville equation as its kernel. An iterative procedure then gives an infinite series of operators; these are multiplied by a given operand, such as the neutron flux, and then truncated to give the desired accuracy. This method determines both perturbed flux profile and magnitude of perturbation. (M.L.S.)

44894 SITING CRITERIA: A NEW APPROACH. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). 22p. (CONF-670402-3). DTIE.

From IAEA Symposium on the Containment and Siting of Nuclear Power Plants, Vienna.

A proposal is made for a means of defining safety standards which will permit complete freedom in the siting of reactors for nuclear power plants. A means of assessing the ability of a reactor to meet the standards is given. (L.C.L.)

44895 NUCLEAR REACTOR FUEL ELEMENT. Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,084,357. Sept. 20, 1967. Priority date Oct. 9, 1964, France.

The design of clustered fuel elements formed by an assembly of small-diameter rods is presented. The fuel assembly is applicable for a heterogeneous reactor cooled by the circulation of a fluid. (J.C.W.)

44896 NUCLEAR FUEL ELEMENTS. (to NUKEM Nuklear-Chemie und-Metallurgie, GmbH). British Patent 1,083,992. Sept. 20,1967. Priority date Sept. 5, 1963, Germany.

Spherical fuel elements for use in high-temperature reactors are designed. Based on graphite containing nuclear fissile and fertile material, the coated particles are mixed and pressed into a sphere. Heating to carbonize the binder results in a suitable sphere. Another method to produce a spherical fuel element consists of an electrographite sphere into which a cylindrical bore is machined. The bore accommodates a mixture of UC fuel with excess graphite. The fuel is in the form of a cylindrical cartridge. (J.C.W.)

44897 NUCLEAR FUEL ASSEMBLY. Ashcroft, David John; Hartwell, Roy (to United Kingdom Atomic Energy Authority). British Patent 1,084,463. Sept. 20, 1967. Filed Feb. 27, 1964.

A nuclear fuel assembly design in which fuel pins are clustered together with control pins of such material as burnable poison is presented. Cellular spacers are employed to separate the pins to allow for bowing under thermal and irradiation stresses in a reactor core. (J.C.W.)

44898 INTEGRAL NUCLEAR REACTOR. Grain, Deryk Ronald (to United Kingdom Atomic Energy Authority). British Patent 1,083,862. Sept. 20, 1967. Filed June 15, 1964.

An integral nuclear reactor design is given in which the core is contained with a heat exchanger in a vessel also containing a primary coolant for circulation through the core and heat exchanger. The primary coolant is a pressurized liquid such as pressurized water. (J.C.W.)

44899 NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,084,090. Sept. 20, 1967. Priority date Sept. 15, 1965, United States.

Boiling water enters into a containment vessel containing the fuel and reflector assemblies. The water is transformed into steam after passing through the fuel assembly. The control system of the reactor has a part of the reflector system and fuel assembly buoyant in water so changes in either vertical position changes the water level in the vessel and changes the reactivity of the reactor. The flow rate of water entering the containment vessel is controlled. (J.C.W.)

44900 APPARATUS FOR EFFECTING EMERGENCY SHUT DOWN OF A NUCLEAR REACTOR. Kirtley, William Fairley; Wray, Dudley (to United Kingdom Atomic Energy Authority). British Patent 1,084,361. Sept. 20, 1967. Filed Sept. 21, 1964.

A design of a pipeline extending through the reactor core and containing a gas of low neutron absorbing cross section is presented. Equipment for injecting a stream of liquid of high neutron absorbing cross section into one end of the pipeline to displace the gas through the other end is described. (J.C.W.)

44901 BOILING NUCLEAR REACTOR. (to Combustion Engineering, Inc.). British Patent 1,084,255. Sept. 20, 1967. Priority date Oct. 30, 1963, United States.

A boiling nuclear reactor design employing a moderator–coolant as the vaporizable medium is presented. This design applies to reactors which have a tendency to vary their heat output with variation of pressure within the reactor. (J.C.W.)

44902 METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN NUCLEAR REACTORS. Koch, Charles; Ranc, Rene (to Commissariat a l'Energie Atomique). British Patent 1,084,922. Sept. 27, 1967. Priority date June 9, 1965, France.

A method of inhibiting the corrosion of graphite in graphite-moderated CO_2-cooled nuclear reactors is given. The addition of a compound containing silicon and hydrogen to the CO_2 at a minimum temperature of the CO_2 in the reactor cooling loop is performed. (J.C.W.)

44903 REACTOR CONTAINMENT VESSEL. Fistedis, Stanley H. (to U. S. Atomic Energy Commission). U. S. Patent 3,349,524. Oct. 31, 1967.

A concrete containment vessel design for a nuclear reactor having jacketed reinforcing cables extending about the vessel through the concrete is given. Each cable can move lengthwise within its jacket. Thus, when an explosion occurs and cracks a certain region of the concrete, the resulting strain of any cable is not limited to the section of the cable where the concrete cracks, but is distributed over the length of the cable. Thus, the cable is not likely to break, and the integrity of the containment vessel is preserved in spite of localized cracking of the concrete. (auth)

44904 REACTIVITY PULSING DEVICE FOR NUCLEAR REACTORS. Raievski, Victor (to European Atomic Energy Community). British Patent 1,084,717. Sept. 27, 1967. Filed May 20, 1964.

A design of a fast nuclear reactor having a two-part core is given. The two rotatable reactivity pulsing wheels are mounted with a gap between them. The mechanical apparatus produces rapid pulses in the reactor. (J.C.W.)

44905 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Poulter, Dennis Ross; Campbell, John Joseph; Cranfield, Raymond Reginald; Shires, George Lister (to United Kingdom Atomic Energy Authority). British Patent 1,086,060. Oct. 4, 1967. Filed Dec. 2, 1963.

A design of a fuel element assembly is given. Each assembly is housed in a pressure tube and the tubes are embedded in a bulk of moderating material. An emergency coolant supply is connected to each tube and in an emergency the fuel rods are sprayed with coolant. (J.C.W.)

44906 TUBULAR FUEL PENCIL HAVING A THIN FLEXIBLE CAN FOR NUCLEAR REACTORS. Alfille, Lucien; Charrault, Jean-Claude; Lafontaine, Francois (to European Atomic Energy Community). British Patent 1,085,384. Sept. 27, 1967. Priority date Aug. 14, 1964, Belgium.

The design of a tubular fuel element for a nuclear reactor is given. Annular spaces between the inner and outer sheaths contain stacks of rings of nuclear fuel. The design of the closure plug is given. (J.C.W.)

44907 MECHANISM FOR EFFECTING THE POSITIONAL ADJUSTMENT OF NUCLEAR REACTOR CONTROL RODS. Vautrey, Louis (to Commissariat a l'Energy Atomique). British Patent 1,086,099. Oct. 4, 1967. Priority date Oct. 22, 1965, France.

The design is given of a mechanism for positioning control rods in a liquid metal cooled fast reactor. The three operators of the mechanism are a vertical operating rod attached to the control rod grab, the horizontal lever arm connecting the first member and the vertical arm projecting outside the reactor vessel. (J.C.W.)

44908 FUEL ASSEMBLY FOR NUCLEAR REACTORS. Costes, Didier (to Commissariat a l'Energie Atomique). British Patent 1,085,700. Oct. 4, 1967. Priority date Oct. 8, 1965, France.

The design of a fuel assembly for liquid metal cooled fast neutron reactors is described. A vertical tubular sleeve with a cluster of pins of canned fertile material at the bottom and above this a cluster of pins of canned fissile material are contained in the assembly. (J.C.W.)

44909 NUCLEAR REACTOR. Ackroyd, Ronald Tunstall; Knights, Herbert Chilvers (to United Kingdom Atomic Energy Authority). British Patent 1,084,712. Sept. 27, 1967. Filed Jan. 28, 1964.

A design of a nuclear reactor core is given. Each core unit is in the form of concentric cylindrical fuel elements, each having eccentric regions of differing infinite multiplication factor. Some of the elements consist of one region containing fuel and another region containing neutron absorbing poison. Control of the reactor is gained by relative rotation of the various regions within a core unit. (J.C.W.)

44910 IMPROVEMENTS IN NUCLEAR FUEL ELEMENTS. (to Snam SpA). British Patent 1,084,750. Sept. 27, 1967. Priority date Dec. 16, 1963, Italy.

A nuclear fuel element formed by metallic U or its alloys coated with Mg or Zn alloys or unalloyed Zn is described. Between the fuel and the coating a layer of Ti is interposed. (J.C.W.)

44911 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Wrigley, Stanley. British Patent 1,084,999. Sept. 27, 1967. Filed Apr. 5, 1965.

The design of a fuel element to produce outstanding neutron economy in a heavy water–moderated and –cooled reactor is presented. A spherical fuel element is described consisting of a clad spherical mass of fuel and supported with a spherical perforated shell. Coolant flows freely to the clad fuel. (J.C.W.)

Marine and Portable Power Reactors

44912 (AED-C-22-08) BIBLIOGRAPHIEN ZUR KERN-FORSCHUNG UND KERNTECHNIK. SEKTION 22: KERNEN-ERGIEANTRIEBE FUER SCHIFFAHRT. (Bibliographies in Nuclear Science and Technology. Section 22: Nuclear Ship Propulsion). Paro, J. N. (comp.) (Zentralstelle fuer Atomkern-energie-Dokumentation, Frankfurt am Main (West Germany)). Aug. 1967. 28p. (In several languages). Dep.

A bibliography on nuclear ship propulsion with 89 references listed is compiled. An availability listing is included. (J.C.W.)

44913 (RCN-76) DUTCH NUCLEAR PROPULSION SHIP REACTOR. Hofman, W. (Reactor Centrum Nederland, The Hague). May 16, 1967. 14p. Dep.

A description of the NEREUS ship propulsion reactor design including the main design parameters is presented. A short review of the present status of the development work is given. (auth)

44914 IMPROVEMENTS IN OR RELATING TO THE CONTROL OF NUCLEAR REACTORS. Challender, Ronald Scott (to United Kingdom Atomic Energy Authority). British Patent 1,085,230. Sept. 27, 1967. Filed Dec. 16, 1963.

The design of a control system of a steam-generating reactor is given. Control rods are designed to be withdrawn at a controlled rate and there are more shut-off rods than control rods in the design. (J.C.W.)

Rocket and Space Reactors

Refer also to abstract 43086.

44915 (LA-DC-8660) DESIGN AND PERFORMANCE OF AN OPEN-WELL SHIELD FOR HIGH-POWER PROPULSION REACTOR TESTING. Graves, Glen A. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 43p. (CONF-670932-2). Dep. CFSTI.

From International Conference on the Physics Problems of Reactor Shielding, Harwell, England.

The 1500 megawatt Phoebus 1B reactor and its 81-inch-diameter open-well shield constitute a unique combination of a high-power reactor source coaxial with a respectably attenuating bulk shield system possessing a single large end opening permitting free radiation leakage. This system is nuclearly rather simple, and is fairly easy to describe analytically, so the results of calculations and measurements made on it may be of interest to a large segment of the shielding community. The kinds of reactors tested in the nuclear propulsion program are discussed; one basic reactor type is presented as a nuclear model with enough detail to permit valid calculations on its external radiation environment. Testing of the shield is discussed to show why a facility shield is needed and what it should do, and particulars of the shield itself are evaluated. The approach to the nuclear design of this 19-inch-thick borated-water shield is sketched carefully, not only to show the reasoning leading to its final configuration, but also because this process lends further insight into the special nature of propulsion reactor testing. Engineering design is not covered, but a careful description is given of the shield's features as built. Measurements relating to the shield system's performance are given. These include its reactivity effect, its thermal performance (including that of its borated-water coolant system), its lateral attenuation, and its effect on neutron fluxes in the area. (auth)

44916 (N-67-22845) SNAP-8 THIRD LOOP OPTIMIZATION. Perez, E. F.; Cleveland, F. R.; Rico, L. (Aerojet-General Corp., Azusa, Calif.). Apr. 22, 1963. 66p. (NASA-CR-72213; TM-345-63-1-106). CFSTI.

A summary of the investigations conducted to define optimum operating parameters for the SNAP-8 third loop is presented. Eutectic NaK and OS-124 were considered as coolant fluids for this loop. A comparison is made between the fluids on the basis of optimum equivalent weights. Also included are analyses developed for optimizing design parameters for the heat exchanger, condenser and the flat tube and fin radiator. (auth)

44917 (N-67-22847) INVESTIGATIONS OF THE SNAP-8 LUBE AND COOLANT LOOP. Perez, E. F.; Tingle, W. W. (Aerojet-General Corp., Azusa, Calif.). Dec. 3, 1964. 65p. (NASA-CR-72218; TM-340-64-1-255). CFSTI.

Additional lube and coolant loop investigations were conducted. Digital computer programs were prepared to conduct radiator design evaluations and to permit off design performance evaluations of the L/C loop. These digital computer programs were used in the evaluation of L/C operating parameters. The effect of vehicle acceleration on the L/C loop was also analyzed and the best location for the L/C expansion reservoir to accommodate the effects of the acceleration was determined. (auth)

44918 (N-67-22849) CYLINDRICAL RADIATOR ANALYSIS WITH INTERIOR INSULATED. Perez, E. F.; Edberg, J. (Aerojet-General Corp., Azusa, Calif.). Apr. 22, 1963. 9p. (NASA-CR-72210; TM-345-63-1-108). CFSTI.

An investigation was made to evaluate the sizes and weights of cylindrical radiators for use in the SNAP-8 heat rejection system. The radiators were sized to provide the required heat rejection, while operating with the maximum external heat load from solar and planetary sources, using OS-124 or NaK as the cooling fluids. The interiors of the cylinders were considered to be insulated with heat radiating from the outside surface of the radiation only. The resulting optimum radiator sizes were compared to an optimum flat radiator configuration. (auth)

44919 (N-67-22850) WEIGHT-AREA TRADE-OFF STUDY FOR A FLAT SNAP-8 RADIATOR. Perez, E. F.; Forrest, D. L. (Aerojet-General Corp., Azusa, Calif.). Apr. 22, 1963. 10p. (NASA-CR-72209; TM-345-63-1-103). CFSTI.

An analysis was made to permit evaluation of the trade off between radiator area and weight. A method was developed to determine the optimum manner in which the radiator projected area can be reduced with a minimum increase in radiator weight. (auth)

44920 (N-67-22853) SEDAN–SNAP-8 DATA ANALYSIS PROGRAM. Yee, D. (Aerojet-General Nucleonics, San Ramon, Calif.). Jan. 1966. 131p. (NASA-CR-72212; TM-4923-66-373). CFSTI.

SEDAN is a series of 3 IBM-7094 computer programs written to analyze steady-state data obtained from the following SNAP-8 test loops: SL-1/PCS-1 Phase 1; RPL-2 Stage 1; and PCS-1 Phase 4. The analysis consists of statistically deriving a set of consistent state point values from the loop instrument readings and to use these values to calculate component performance parameters. (auth) (STAR)

44921 (N-67-22879) CUP-SEAL INTERFACE CHARACTERISTICS. Kreeger, A. H.; Anson, O. C. (Aerojet-General Corp., Azusa, Calif.). Apr. 22, 1963. 53p. (NASA-CR-72222; TM-355-63-5-102). CFSTI.

Tests were conducted to investigate the stability of liquid-liquid and liquid-vapor interfaces in a test rig designed to simulate a proposed dynamic seal for the SNAP-8 turbine alternator assembly. The fluids tested were water, mercury, and glycerine. Visual examination, pressure measurements, and power loss measurements were conducted with a 3.510 inch diameter stationary disk in a rotating fluid field contained by a 3.815 inch inside diameter rotating housing. Rotational speeds were limited to 2000–5000 rpm since the housing was fabricated from lucite. The interface radius was varied from 1.75 inch to 1 inch for all measurements. The photographs show that the interface was very wavy, but was not significantly affected by a change in rotational speed. Viscosity and interface radius (interface level) were evidently the only influencing variables. Power loss measurements showed that losses of 0.2 and 0.3 hp were realized at 12,000 rpm for mercury and glycerine, respectively. (auth)

44922 (N-67-22888) ELECTROMAGNETIC PUMPS USED IN SNAP-8 TEST SUPPORT EQUIPMENT. Bradley, S. L. (Aerojet-General Corp., Azusa, Calif.). Mar. 2, 1966. 11p. (NASA-CR-72214; TM-4936-66-393). CFSTI.

Alternating current electromagnetic pumps used in SNAP-8 tests are discussed. The operating characteristics, problems, and failures encountered and action taken and recommended to improve performance and reduce failures are considered. (auth)

44923 (N-67-22890) EVALUATION OF ALTERNATE LUBRICANT-COOLANT FLUIDS FOR SNAP-8. Wood, P. I.; Carter, J. M.; Cassidy, F. H. (Aerojet-General Corp., Azusa, Calif.). Sept. 9, 1965. 51p. (NASA-CR-72219; TM-4921-65-1-327). CFSTI.

A study of alternate lubricant/coolant fluids for SNAP-8 was made to update the evaluation which led to the selection of polyphenyl ether (4P3E) some two years prior. Ten candidate fluids were evaluated; of these, the four most promising fluids were compared in as much depth as available data permitted. Properties of the fluids are tabulated in an appendix. (auth)

44924 (N-67-25841) CONTROLS ANALYSIS OF NUCLEAR ROCKET ENGINE AT POWER RANGE OPERATING CONDITIONS. Arpasi, Dale J.; Hart, Clint E. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 67p. (NASA-TN-D-3978). CFSTI.

Techniques used to evaluate the dynamics of a nuclear rocket engine for control purposes are presented. A linear analysis, applied to transfer functions describing a NERVA-type engine at various operating conditions, was used to develop stable engine control in the power range of operation. The power range of operation is defined as that region of engine operation above 1 percent reactor power and 10-percent propellant weight flow. The effects of operating level and reactor period on the engine dynamics were considered in the analysis by investigating these dynamics at four engine operating levels and three reactor periods. Exhaust-nozzle chamber temperature and pressure were considered the primary engine variables to be controlled because of the relation to the engine specific impulse and thrust. Two methods of temperature control were investigated in terms of system dynamics: (1) the use of an inner-reactor-power control loop manipulated by a temperature controller and (2) direct manipulation of the control drums by the temperature controller with no direct control of reactor power. The results indicated that slightly better bandwidths could be achieved with the use of an inner-power loop. The power loop partly eliminated the restrictions imposed on the gain of the temperature controller by the effects of reactor period, thus allowing increased temperature-loop bandwidth. The effects of operating level on the response of the temperature loop were diminished by the use of adaptive-gain control. The linear analysis at the various operating levels was used to obtain a functional relation between the controller gain and chamber pressure for use in an adaptive controller. (auth) (STAR)

44925 (N-67-26294) INVESTIGATION OF RADIATION EFFECTS PROBLEMS IN NUCLEAR HEAT EXCHANGER ROCKETS. Final Summary Report. Crabtree, R. D.; Wheeler, G. A. (General Dynamics/Fort Worth, Tex.). Jan. 21, 1963. Contract NAS8-1609. 595p. (NASA-CR-84041; FZK-160). CFSTI.

Components and subsystems to be used in the RIFT vehicle guidance and control system were irradiated at 75°F to determine their tolerance to a radiation environment. The components included diodes, resistors, capacitors, and gap switches. It was determined that most of the components have satisfactory radiation resistance for use in the RIFT vehicle. One type of capacitor used in the exploding bridge wire circuit and the 1N338 diodes failed. The subsystems consisted of a gyroscope and circuitry, and a control computer. These subsystems performed well in the gamma dose-rate study, but, as soon as neutron exposure began, the subsystems failed. The integrated neutron flux at which these subsystems failed indicates their toleration for the RIFT vehicle radiation field is marginal. (auth) (STAR)

44926 (NASA-TM-X-1441) CONDITIONING AND STEADY-STATE PERFORMANCE OF SNAP-8 TUBE-IN-SHELL MERCURY BOILER. Albers, James A.; Wintucky, William T.; Gorland, Sol H. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Sept. 1967. 45p. CFSTI.

As part of the overall SNAP-8 development program, experimental data were obtained from the tube-in-shell boiler tested in the SNAP-8 facility at Lewis Research Center. The boiler was a cross-counterflow heat exchanger consisting of four 1-inch tubes coiled inside a concentric cylindrical annulus. An analysis of the boiler performance is presented for a total operating time of 1087 hours. The boiler-outlet heat-transfer parameters increased with time to approximately 300 hours of boiler operation and did not appreciably change thereafter. For boiler operation after 300 hours, the average outlet quality was 93 percent with an average superheat of 300°F (170°K). Average outlet absolute enthalpy was 153 Btu per second (3.55×10^5 J/kg), which is 5 percent less than design. Although the boiler mercury-vapor outlet quality and terminal temperature difference remained essentially constant after 300 hours of operation, the boiler internal heat transfer continued to improve. The NaK outer-shell temperature profiles and the boiler mercury inventory indicated that the plug sections of the two outer boiler tubes were flooded. Performance curves of the boiler indicated that the chosen design NaK- to mercury-flow-rate ratio was above its optimum value. At about 700 hours of operation, the overall pressure drop ranged from 78 to 103 pounds per square inch ($5.4 \text{ to } 7.1 \times 10^5$ N/m^2), which corresponds to mercury-flow rates of 6350 to 9350 pounds per hour (2880 to 4240 kg/hr). There was a slight increase in overall pressure drop with increased pinch-point temperature difference. The NaK side boiler pressure drop ranged from 3 to 6.5 pounds per square inch ($2 \text{ to } 4.5 \times 10^4$ N/m^2, which corresponded to NaK flows of 20,000 to 33,000 pounds per hour (9100 to 15,000 kg/hr), respectively. (auth)

44927 (UCID-15204) SOME FIRST THOUGHTS ON THE SPR-6 REACTOR CONTROL SYSTEM. Space Power Note No. 230. Grissom, M. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 2, 1967. Contract W-7405-eng-48. 14p. Dep. CFSTI.

A pneumatic servo system and a general logic control scheme are presented as a method for controlling the SPR-6 reactor. Some pneumatic devices utilizing the techniques of fluidic technology are examined. (auth)

44928 THERMODYNAMIC CYCLE PARAMETERS ANALYSIS OF SPACE NUCLEAR POWER PLANTS. Kalafati, D. D. At. Energ. (USSR), 22: 432-9(June 1967). (In Russian).

The optimum parameters of the thermodynamic cycle of space nuclear power plants were analyzed under two basic conditions: during steady and variable thermal power of the reactor. The solution for each of these two cases was obtained by use of two basic criteria: minimum specific surface of the radiator and minimum specific mass of station. The method for the analysis of the optimum parameters was developed. It was shown that for each of the two reactors and steam generators there was a given limiting electric power and a corresponding minimum specific mass. Additional increase of the electric power leads to increase of the specific surface of the radiator and simultaneously of the specific mass of the station. (tr-auth)

44929 COMPARISON OF TWO FUEL-ELEMENT SHAPES. Walter, Carl E. (Univ. of California, Livermore). Nucl. Appl., 3: 615-9(Oct. 1967).

Externally cooled fuel pins and internally cooled fuel tubes are compared for otherwise identical reactors. The tube design overcomes the deficiency of the pin design in fission-gas pressure venting. Fuel tubes have lower temperature differentials and thermal stresses than fuel pins. A greater number of smaller fuel tubes are required to replace fuel pins. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 43297, 43313, 44497, 44502–44511, 44518, 44532, and 44541.

44930 (ANL-7208) ZPR-9 ASSEMBLIES NO. 6-9 CRITICAL EXPERIMENTS. Doerner, R. C.; Knapp, W. G.; Karam, R. A.; Butler, D. K. (Argonne National Lab., Ill.). Mar. 1967. Contract W-31-109-eng-38. 104p. Dep. CFSTI.

CRITICAL ASSEMBLIES—oxide-reflected system of ZPR-9 Assembly No. 7 fast, physics measurements on; core for ZPR-9 Assembly No. 9, poison effects on; core for ZPR-9 Assembly No. 8 fast, description of urania-fueled tungsten-diluted; lattice parameters of ZPR-9 Assemblies 6–9; critical mass values for ZPR-9 Assemblies 6–9

REACTIVITY—worths of nonhydrogenous materials in ZPR-9 Assembly No. 7, determination of central; worths of polyethylene in ZPR-9 Assembly No. 7, determination of central; worths of boron–lucite mixtures in ZPR-9 Assembly No. 7, determination of central; worths of nonhydrogenous materials in ZPR-9 Assembly 9; worths of hydrogenous materials in ZPR-9 Assembly 9; worths of boron–lucite mixtures in ZPR-9 Assembly No. 9; worth of alumina reflector material used in ZPR-9 assembly No. 9; worth of materials near core boundary in ZPR-9 Assembly No. 8; worths of nonhydrogenous material in ZPR-9 Assembly No. 8, determination of central; worths of hydrogenous material in ZPR-9 Assembly No. 8, determination of central; worths of boron-lucite mixtures in ZPR-9 Assembly No. 8, determination of central; worths of boron sleeve in ZPR-9 Assembly No. 6; worths of boron in ZPR-9 Assembly No. 7; worth of boron sleeve in ZPR-9 Assembly No. 8 reflector, spatial dependence of; worth measurements of reflector voids in ZPR-9 assembly No. 8; worth of hydrogenous materials in reflector of ZPR-7 Assembly No. 6; effects of small samples in ZPR-9 Assembly No. 7, spatial distribution of; worths of materials at reactor center; normalized

NEUTRONS, PROMPT—lifetime measurements in ZPR-9 Assembly No. 7; lifetime measurements in ZPR-9 Assembly No. 9; lifetime measurements in ZPR-9 Assembly No. 8; lifetime measurements for ZPR-9 Assemblies 6–9

BORON—reactivity worth measurement in ZPR-9 Assembly No. 7; reactivity worth measurements in ZPR-9 Assembly No. 8, spatial dependence of

URANIUM ISOTOPES U-238—fission rate measurements in ZPR-9 Assembly No. 7; fission rate measurements in ZPR-9 Assembly No. 8; fission rates in ZPR-9 Assembly No. 9

URANIUM ISOTOPES U-235—fission rate measurements in ZPR-9 Assembly No. 7; fission rate measurements in ZPR-9 Assembly No. 8; fission rates in ZPR-9 Assembly No. 9; reactivity effects of small samples in ZPR-9 Assembly No. 7, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 8 of small samples of, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 9 of small samples of, spatial distribution of

FISSION—ratios of uranium-238/uranium-235, measurement in ZPR-9 Assembly No. 7 of; ratios of uranium 238/uranium-235, measurements in ZPR-9 Assembly No. 8 of

URANIUM ISOTOPES U-233—fission rate measurements in ZPR-9 Assembly No. 7; fission rates in ZPR-9 Assembly No. 9

URANIUM ISOTOPES U-234—fission rate measurements in ZPR-9, Assembly No. 7; fission rates in ZPR-9 Assembly No. 9

URANIUM ISOTOPES U-236—fission rate measurements in ZPR-9 Assembly No. 7; fission rates in ZPR-9 Assembly No. No. 9

NEPTUNIUM ISOTOPES Np-237—fission rate measurements in ZPR-9 Assembly No. 7; fission rates in ZPR-9 Assembly No. 9

PLUTONIUM ISOTOPES Pu-239—fission rate measurements in ZPR-9 Assembly No. 7; fission rates in ZPR-9 Assembly No. 9

BORON ISOTOPES B-10—fission rate measurements in ZPR-9 Assembly No. 7; capture rate measurements in ZPR-9 Assembly No. 8; fission rates in ZPR-9 Assembly No. 9; reactivity effects of small samples in ZPR-9 Assembly No. 7, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 8, variations due to size on; reactivity effects in ZPR-9 Assembly No. 9 of small samples of, spatial distribution of

ETHYLENE POLYMERS—reactivity effects of small samples in ZPR-9 Assembly No. 7, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 7 of small samples of borated, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 8 of small samples of borated, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 9 of small samples of, spatial distribution of; reactivity effects in ZPR-7 Assembly No. 9 of small samples of borated, spatial distribution of

REACTOR FUEL ELEMENTS—reactivity worths of ZPR-9, determination of spatially dependent

ETHYLENE POLYMERS—reactivity effects in ZPR-9 Assembly No. 8 of small samples of, spatial distribution of

TUNGSTEN—reactivity effects in ZPR-9 Assembly No. 8, spatial distribution of; reactivity effects in ZPR-9 Assembly No. 9, spatial distribution of

RHENIUM—reactivity effects in ZPR-9 Assembly No. 8, spatial distribution of; reactivity effects in ZPR-9, Assembly No. 9, spatial distribution of

GADOLINIUM—reactivity effects in ZPR-9, Assembly No. 9, spatial distribution of

EUROPIUM—reactivity effects in ZPR-9, Assembly No. 9, spatial distribution of

DYSPROSIUM—reactivity effects in ZPR-9, Assembly No. 9, spatial distribution of (M.L.S.)

44931 (ANL-7303) EFFECTIVENESS OF CONTROL-ROD MATERIALS. Iskenderian, H. P. (Argonne National Lab., Ill.). Apr. 1967. Contract W-31-109-eng-38. 29p. Dep. CFSTI.

The determination of control rod materials efficiency is given. A theoretical development of the reactivity loss due to control rod insertion is presented in terms of three group theory. An experimental check of theory is made; results are tabulated for Hf, In, Au, Ag, Co, Eu, B, and Cd. Data from ZPR-1, GEAP-3201, FPR-13, FPR-11, and FPR-12 are discussed. 9 references. (M.L.S.)

44932 (ANL-7371) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1967. (Argonne National Lab., Ill.). Sept. 28, 1967. Contract W-31-109-eng-38. 126p. Dep. CFSTI.

EXPERIMENTAL BOILING WATER REACTOR—pressure vessel for, corrosion testing of

PRESSURE VESSELS—corrosion tests of EBWR

EXPERIMENTAL BREEDER REACTOR-II—operation of; power coefficient measurements in, effects of fuel element position on; coolant system equipment development for

REACTOR FUEL ELEMENTS—fuel cycle facility for EBR-II, operation of; remote handling system for EBR-II, operation of; swelling of EBR-II, effects of pressure on; development of higher temperature and higher burnup; alteration of radial blanket of EBR-II, design for; radiation testing of EBR-II; radiation effects on mixed-carbide; fabrication of carbide pellet-type; cladding for, temperature and radiation effects on materials for

REACTIVITY—measurements in EBR-II core, effects of power level on; perturbation measurements in ZPR-3, use of small samples for central

REACTOR CONTROL ELEMENTS—reactivity worth at full power of EBR-II; design of all-absorber type

REACTOR FUELS—chemical analyses of EBR-II; impurities in EBR-II fuel cycle production of, effects of trace-element; fabrication of, use of molybdenum-plutonium-uranium alloys in; compatibility with potential jacketing materials of carbide; fission products in mixed-oxide, distribution of gamma-emitting; analysis of, use of laser microsampling technique for

SODIUM—effects on physical properties of EBR-II structural specimens; evaluation of coolant, techniques for

CRITICAL ASSEMBLIES—fission ratio measurements for uranium isotopes in ZPR-3, central; neutron spectrum in ZPR-6, effects of sodium voiding on; fission ratios for uranium and neptunium in ZPR-9, measurements of; pressure vessel for ZPPR, safety factor calculations for

FISSION—ratio measurements in ZPR-3 of uranium 233/uranium 235; ratio measurements in ZPR-3 of uranium 234/uranium 235; ratio measurements in ZPR-3 of uranium 236/uranium 235; ratio measurements in ZPR-3 of uranium 238/uranium 235; ratios for uranium and neptunium, measurements in ZPR-9 of

URANIUM ISOTOPES U-238—foil activations in ZPR-3; fission ratios for, measurements in ZPR-9 of

MOLYBDENUM ALLOYS—Mo-Pu-U, fuel element materials of, chemical analysis of; Mo-Pu-U, expansion characteristics of

PLUTONIUM ALLOYS—Mo-Pu-U, fuel element materials of, chemical analysis of; Mo-Pu-U, expansion characteristics of

URANIUM ALLOYS—Mo-Pu-U, fuel element materials of, chemical analysis of; Mo-Pu-U, expansion characteristics of

ARGONNE ADVANCED RESEARCH REACTOR—core for, heat transfer analysis of; beam and through tube development for; instrumentation and control of, development of

REACTORS, FAST—coolant dynamics studies for; containment structure for, computer code for analysis of

REACTORS, LIQUID METAL-COOLED—coolant dynamics studies for; containment structure for, computer code for analysis of

SEALS AND GLANDS—analyses of rotating plug

INCONEL X—radiation effects on EBR-II fuel element springs of

SPRINGS—radiation effects on Inconel X

URANIUM ISOTOPES U-235—fission ratios for, measurements in ZPR-9 of

NEPTUNIUM ISOTOPES Np-237—fission ratios for, measurements in ZPR-9 of

THERMOCOUPLES—development of high temperature fuel-pin

FLOWMETERS—development for FFTF

TRANSDUCERS—development of fission-gas pressure

VANADIUM ALLOYS—corrosion in liquid sodium of

NEUTRON CROSS SECTIONS—calculation for Doppler-broadened, revision of computer codes for

FISSION PRODUCTS—distribution in mixed-oxide fuels of gamma-emitting

REMOTE CONTROL EQUIPMENT—development of master-slave manipulator systems

HEAT TRANSFER—liquid-vapor behavior studies for sodium coolant systems

URANIUM—recovery from low-enrichment fuels, fluoride volatility process for

PLUTONIUM—recovery from low-enrichment fuels, fluoride volatility process for

FUSED SALTS—processing chemistry for systems of

REACTOR EXPERIMENTAL FACILITIES—development of AARR beam and through tube

HODOSCOPES—development of fast-neutron

PUMPS (LIQUID METAL)—development for TREAT integral sodium loop

TANTALUM CARBIDES—expansion coefficients of, temperature effects on

REACTORS, WATER-COOLED—heat transfer studies for, particle-coolant

REACTOR SAFETY—reactor containment structure analysis, computer codes for

REACTORS, BREEDER—containment structure for, computer code for analysis of (M.L.S.)

44933 (BNWL-504) PRTR CONTAINMENT VESSEL LEAK RATE TEST EXPERIENCE. Hayes, D. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1967. Contract AT(45-1)-1830. 26p. Dep. CFSTI.

The leak rate of the Plutonium Recycle Test Reactor (PRTR) containment structure was measured using the reference volume

method. The measurement was made with the containment system in an "as is" condition at a vessel pressure of 10 psig. The accuracy of the test results was verified by superimposing a known leak rate of 0.88%/day on the existing vessel leak rate. The measured leak rate increased from 0.40% to 1.19%/day, giving a 0.79% increase, versus an expected 1.28% or 0.88% increase. The final vessel leakage rate was 0.43 ± 0.026%/day in comparison to an allowable operational leak rate of 0.678%/day. A thorough leak check of the vessel penetrations was made while the vessel was pressurized. All the leaks detected were small. The repair methods were carefully selected on the basis that they could not increase the leak rate through the penetration. At the completion of the test, the vessel was depressurized and the repairs made. The vessel was then repressurized to 10 psig. Three of the repairs were successful and the leaks were eliminated, but only minor improvement was made in the fourth. The mechanical closures, including the underwater fuel transfer gate (sluice gate), air lock doors, vacuum relief valves, and effluent containment valves, held very well, and only minor leaks were detected at these locations. (auth)

44934 (BNWL-SA-780) THEORETICAL ANALYSES OF HOMOGENEOUS PLUTONIUM CRITICAL EXPERIMENTS. Richey, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 3, 1966. Contract AT(45-1)-1830. 16p. Dep. CFSTI.

A computational analysis of data from an accumulation of clean experiments with plutonium fueled assemblies is presented. Simplification approximations of the transport equation and cross section data are evaluated. Associated errors are predicted. Critically safe masses and dimensions are presented for aqueous $Pu(NO_3)_4$ solutions and ^{239}Pu–water mixtures. A theory–experiment comparison is presented. Calculated eigenvalues are tabulated as a function of S_N order and as a function of anisotropic scattering order. 11 references. (M.L.S.)

44935 (BNWL-SA-1204) OPERATING EXPERIENCE WITH PLUTONIUM FUELS IN PRTR. Freshley, M. D.; Goldsmith, S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 25, 1967. Contract AT(45-1)-1830. 31p. (CONF-671005-2). Dep. CFSTI.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

Irradiation of experimental Pu fuel elements in the PRTR is discussed. Fuel materials such as UO_2, Al–Pu, and PuO_2–UO_2 have been evaluated utilizing a basic 19-rod cluster fuel element design. Methods for preparation of Pu fuels are outlined. Burnup experiments for high power density fuels are discussed. (M.L.S.)

44936 (GA-8114) LATTICE PHYSICS STUDIES. Quarterly Progress Report for the Period Ending June 30, 1967. Trimble, G. D.; Gozani, T.; Preskitt, C. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). July 10, 1967. Contract AT(04-3)-167. 49p. (EURAEC-1903). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The experimental studies at the Lattice Experimental Facility (LEF) are presented. These include: comparative studies on detector systems for use with LEF, an efficiency determination of the collimator system, thermal neutron spectral measurements in an aqueous solution of $Er(NO_3)_3$, thermal neutron spectral measurements in small U rods, neutron conservation tests in $Er(NO_3)_3$, computational procedures for analysis of single rod and lattice experiments, and pre-analysis lattice cell spectrum measurements. Results are given. 10 references. (M.L.S.)

44937 (GEAP-5513) PLUTONIUM SUBCRITICAL EXPERIMENT PROGRAM. Quarterly Report No. 12, April 1–June 30, 1967. Carver, J. G. (General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.). Contract AT(04-3)-189. 13p. (EURAEC-1913). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Irradiation of a 2 : 1 water : Pu fuel ratio lattice is described. Data reduction for the resonance and fission foil irradiations is discussed. (M.L.S.)

44938 (IDO-17204) ANALYSIS OF SNAPTRAN REACTOR BEHAVIOR. Kessler, W. E.; Prael, R. E.; Weydert, L. N. Jr. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). June 1967. Contract AT(10-1)-205. 19p. Dep. CFSTI.

The SNAPTRAN program provides nuclear safety information of the rapid transient behavior of ZrH–U fuels. Knowledge of the fission energy source as a function of time in conjunction with knowledge of the fuel temperature yielded a well defined trend from which an evaluation of the specific heat of the fuel was obtained. The specific heat was found to be described by a linear temperature-dependent term plus an Einstein oscillator model temperature-dependent term. The SNAPTRAN reactor temperature coefficient, calculated using this specific heat formulation, varied from −0.10 to −0.18 cents/°F in the range of 100 to 1200°F. (auth)

44939 (KAPL-P-3370) AN EXPERIMENTAL METHOD OF DETERMINING THE ABSOLUTE POWER LEVEL IN LOW-POWER NUCLEAR REACTORS. Ebert, David D. (Knolls Atomic Power Lab., Schenectady, N. Y.). July 17, 1967. Contract W-31-109-eng-52. 8p. (CONF-670713-8). Dep. CFSTI.

From 3rd Meeting of the Reactor Operations Division of the American Nuclear Society, Atlantic City, N. J.

An experimental method has been devised to obtain the absolute local and total power level in critical assemblies. The method involves determination of a conversion factor which relates the count rate of a fission product γ detector to the fission rate in a fuel element during an activation. The conversion factor is obtained by using a fission rate calibrated U-Zircaloy foil. Fission rate calibration is accomplished by irradiation of the foil in a neutron flux of known magnitude and known spectrum. The uncertainty of the absolute power level determination is ±6% using this technique. (auth)

44940 (LA-3611) REVIEW OF CRITICALITY ACCIDENTS. Stratton, William R. (Los Alamos Scientific Lab., N. Mex.). Jan. 1967. Contract W-7405-eng-36. 111p. Dep. CFSTI.

A description of criticality accidents is presented along with a discussion of the characteristics of prompt power excursions. Thirty-four accidental power transients are described. In each case, enough detail is given to visualize the physical situation, the cause or causes of the accident, the history and characteristics of the transient, the energy release, and consequences, if any, to personnel and property. This review includes only those incidents which occurred before Janaury 1967. (auth)

44941 (LA-3612) CRITICALITY DATA AND FACTORS AFFECTING CRITICALITY OF SINGLE HOMOGENEOUS UNITS. Stratton, W. R. (Los Alamos Scientific Lab., N. Mex.). July 1964. Contract W-7405-eng-36. 53p. Dep. CFSTI.

The critical parameters of single homogeneous units are examined and tabulated. The study includes both theoretical and experimental results which are compared extensively in order to establish the accuracy of the theoretical method. The experimental data are reduced to standard conditions to facilitate this comparison and to investigate the consistency of the large number of critical experiments. Given the validity of the calculational scheme, the various affects of diluents (including moderators), reflectors, density charges, and poisons are studied. Finally, by application of the theory, results are obtained which are inaccessible or very difficult to obtain by experimental methods. (auth)

44942 (LA-DC-8538) SHIELD ANALYSIS OF AN EXPERIMENTAL FAST REACTOR. Dudziak, Donald J.; Battat, M. E. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 23p. (CONF-670932-1). Dep. CFSTI.

From International Conference on the Physics Problems of Reactor Shielding, Harwell, England.

A method of analysis to determine the detailed spatial distribution of neutron and γ-ray absorbed doses external to the fast core Los Alamos Molten Plutonium Burnup Experiment is presented. The neutron codes CRAM and DDK were used for diffusion theory and S_4 transport-approximation calculations. In the calculations of γ-ray energy deposition, point-kernel integration and Monte Carlo methods were used. (J.C.W.)

44943 (N-67-25854) FAST-NEUTRON BEAM IRRADIATION FACILITY IN THE NASA PLUM BROOK TEST REACTOR. Smith, John R.; Kroeger, Erich W.; Asadourian, Armen S.; Spagnuolo, Adolph C. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1967. 26p. (NASA-TM-X-1374). CFSTI.

A facility built around the HB-6 beam hole of the Plum Brook Reactor is described. The facility is designed for testing the effects of radiation on electrical components, such as semiconductor diodes, transistors, and integrated circuits, and for developing flux-measuring devices. The nuclear radiation environment in the test section of the facility has a range of 4.6×10^4 to 4.0×10^7 n/cm²-sec sec (>0.1 MeV); a thermal-neutron flux of 1×10^5 n/cm²-sec; and a gamma exposure rate of 1.3×10^4 to 9.8×10^4 R/hr. The method for varying the fast-neutron flux, the function of the biological shielding, the placement of specimens in the test section for irradiation, and the schemes for monitoring neutron and gamma fluxes during irradiation are discussed. A typical irradiation test of silicon diode rectifiers is described. (auth) (STAR)

44944 (NP-16953) NEUTRON DIFFUSION AND MULTIPLICATION IN REACTOR LATTICES. Haroon, Muhammad Rafiq (Imperial Coll. of Science and Technology, London (England). Nuclear Power Group). Sept. 1966. 378p. Dep.

Thesis.

Neutron flux distribution and buckling measurements were made as a function of fuel loading in a subcritical assembly. The measurements were made in a square configuration. Control rod effectiveness measurements were also made. Results were correlated on the basis of diffusion theory. Values for k_∞ and B_m^2 are shown as a function of number of fuel elements; reflector savings are plotted as a function of reflector thickness. Analysis of control rod effects is based on super-cell calculations and the heterogeneous theory. (M.L.S.)

44945 (ORNL-TM-1992) BULK SHIELDING FACILITY QUARTERLY REPORT, APRIL, MAY, AND JUNE OF 1967. Tabor, W. H. (comp.) (Oak Ridge National Lab., Tenn.). Sept. 14, 1967. Contract W-7405-eng-26. 29p. Dep. CFSTI.

The BSR was operated for 662.0 hr and produced 1,277,795 kwhr of energy. The major portion of this operation was for basic research. Remote operation of the BSR was begun on May 31, 1967; with the exception of one short shutdown due to the loss of the picture on the TV monitor, remote operation has been very satisfactory. All startups and balancing of shim rods have been performed at the local console. The PCA was operated during April and May for graduate and undergraduate students of the Department of Nuclear Engineering of the University of Tennessee. (auth)

44946 (RFP-1017) CRITICAL MASSES OF OIL REFLECTED, ENRICHED URANIUM METAL ASSEMBLIES WITH POLYURETHANE CENTERS. Ernst, B. B. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 6, 1967. Contract AT(29-1)-1106. 9p. Dep. CFSTI.

The critical masses of oil reflected, enriched uranium spherical assemblies of inside uranium radii, 0.0, 4.017, 8.010, and 12.011 cm with a low-density foam in the central cavity were measured to be 24.3, 31.65, 52.1, and 81.3 kg. Critical masses were determined by reciprocal multiplication measurements on fully reflected assemblies and are compared with calculations. (auth)

44947 (RFP-1021) CRITICAL MASSES FOR PARTIALLY STEEL REFLECTED ENRICHED URANIUM METAL ASSEMBLIES. Rothe, Robert E. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 18, 1967. Contract AT(29-1)-1106. 16p. Dep. CFSTI.

Sixty-one critical masses were measured for spherical or hemispherical enriched U assemblies. The assemblies differed in the amount of mild-steel reflector outside the U. They also differed in the size of a central cavity in the U. The cavity was formed by the omission of small-radius U components from the assembly. This central cavity contained either air or mild steel. The critical masses were determined by the extrapolation of reciprocal multiplication data for subcritical assemblies. (auth)

44948 (UJV-1845) DYNAMIKA MODERATORU REAKTORU TR-O S REGULACNIM PREPADEM. Analogove Resent. (The Dynamics of TR-O Reactor Moderator Level Controlled by a Circular Overflow. Analogue Solution). Krejci, M.; Blazek, J.; Zikan, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1967. 50p. (In Czech). Dep.

A control device in the form of a circular vertically moving overflow was designed to control the TR-O reactor by heavy water moderator level. The dynamics of the reactor hydraulic system with the controlling overflow positioned in a special auxiliary vessel is solved with an analogue computer. The essential nonlinearities of the system are considered. A number of variants is investigated which involve various characteristic values of the control device (diameters of the overflow edge, of the overflow tube and of the auxiliary vessel), of the connection tubing (diameter and length), of the reactor (fuel elements charge and water flow), as well as varying hydraulic losses. The effect of these parameters on the transients of moderator level is studied for a stepwise change of overflow position. Each variant is evaluated with respect to the transients, integral deviation, rise time and delay. The parameters range which secures appropriate control properties of the reactor TR-O is determined on the base of the result obtained. (auth)

44949 SOME STUDIES ON THE EFFECTIVENESS OF CONTROL RODS. Konishi, Toshio (Tokyo Univ.); An, Shigeshiro; Togo, Yasumasa; Nagai, Fumio. J. Nucl. Sci. Technol. (Tokyo), 4: 394-9(Aug. 1967).

The linear extrapolation distances for epi-thermal neutrons on various neutron absorbers were obtained experimentally with the use of a natural UO_2–H_2O cyrindrical exponential column. The measured flux distributions or flux-depression distributions around the control rod were compared with calculated values. It was confirmed that, except in the region immediately around the absorber, the radial flux distributions or depressions can be calculated accurately by the two-group approximation using these linear extrapolation distances obtained experimentally for epithermal neutrons, and those calculated by the Kushneriuk-McKay method for thermal neutrons. The flux depressions on the surface of the control rod were measured to be almost constant and independent of the lattice position of the control rod inserted. This fact simplifies the calculation for evaluating the reactivity worth of the control rod by the perturbation theory. The scattering effect of the control rod on its effectiveness was studied experimentally with the use of SHE, a 20% enriched UO_2-graphite moderated critical assembly. Sometimes a scatterer (graphite slug) inserted inside a hollow control rod decreases the reactivity worth by more than 10%. (auth)

44950 RECOIL RELEASE OF FISSION-GAS FROM UO_2. Inoue, Kiyoshi; Taniguchi, Kaoru; Ohsawa, Yasuo (Hitachi Ltd., Tokyo). J. Nucl. Sci. Technol. (Tokyo), 4: 387-93(Aug. 1967).

The fission-gas released from in-core UO_2 pellets was investigated with the He-swept fuel irradiation facility installed in the Hitachi Training Reactor. It was found that the release rate of fission-gas increased gradually as irradiation continued for 5 hr under a constant thermal neutron flux of 1.0×10^{12} n/cm^2/sec and at a fuel temperature of about 150°C. This observation indicates that a recoil-activated release mechanism may be more effective than direct-recoil release in the case of clad fuel in the region of temperature where fission-gas release rate is temperature independent. (auth)

44951 THE DELAYED-NEUTRON FRACTION: NEUTRON LIFETIME RATIO IN A TRIGA REACTOR FROM NOISE ANALYSIS. Bars, Bruno (Technical Univ. of Helsinki). Nucl. Sci. Eng., 30: 104-8(Oct. 1967).

The power level fluctuations of the TRIGA Mark II reactor at Otaniemi, Finland, have been measured at a power of 3 W. A compensated ionization chamber was used and the signal was analyzed by utilizing a filtering technique. A simple theoretical model for the power spectral density associated with the neutron noise was fitted to the experimental results in the frequency range 4 to 400 cps by the least-squares sum method. Calculations were made on a digital computer, which gave a β/l-value of 121.4 (units) 1/sec. For a delayed-neutron fraction with $\beta = 0.0073$, this implies a prompt-neutron lifetime, l, equal to $60.1 \pm 3\ \mu$ sec. Noise measurements on TRIGA reactors have not been reported earlier. (auth)

44952 IMPROVEMENTS RELATING TO CORE STRUCTURES FOR GAS-COOLED NUCLEAR REACTORS. Derbyshire, Edward Carlos; Hoskins, Leonard Maxwell (to Fairey Engineering Ltd.). British Patent 1,086,056. Oct. 4, 1967. Filed May 24, 1963.

The design of a reactor core is described for improvement of the thermal barrier construction between the central test region and the driver region. (J.C.W.)

44953 IMPROVEMENTS RELATING TO LAGGING BOXES FOR NUCLEAR REACTORS. Ward, Francis Robert; Holden, Ralph Owen (to Fairey Engineering Ltd.). British Patent 1,086,055. Oct. 4, 1967. Filed May 24, 1963.

An improved design of a lagging box for use as a thermal insulation component is given. The large temperature differences existing in operation between the two sides of the lagging box demanded that a lagging box accommodate the resultant thermal expansion without the production of excessive stresses. (J.C.W.)

44954 METHOD OF ASSEMBLING THE CORE OF A NUCLEAR REACTOR. Hoskins, Leonard Maxwell; Norgrove, Royal Malcolm (to Fairey Engineering Ltd.). British Patent 1,086,051. Oct. 4, 1967. Filed May 2, 1963.

A method of assembling the core of a gas-cooled graphite-moderated test nuclear reactor is given. Apparatus for inserting and removing the central core stack into and from the central well in the outer part of the core is described. (J.C.W.)

44955 IMPROVEMENTS RELATING TO NUCLEAR REACTOR PIPE COUPLING MEANS. Reddick, Eric Harry (to Fairey Engineering Ltd.). British Patent 1,086,052. Oct. 4, 1967. Filed May 10, 1963.

The design of a pipe coupling device for supplying gas to or exhausting it from the coolant loops of the core of a gas-cooled reactor is given. (J.C.W.)

44956 IMPROVEMENTS RELATING TO CORE SUPPORTING PLATFORMS FOR NUCLEAR REACTORS. Hoskins, Leonard Maxwell; Derbyshire, Edward Carlos (to Fairey Engineering Ltd.). British Patent 1,086,053. Oct. 4, 1967. Filed May 13, 1963.

The design of a bedplate for the central test portion of the moderator of a zero-energy gas-cooled experimental reactor is given. The central test portion structure is removable from

the central passage in the annular driver portion for the purpose of changing the fuel pattern contained in it. Surrounding the central structure is the separately-supported annular driver portion of the moderator structure maintained at a considerably lower temperature during operation of the reactor. (J.C.W.)

44957 IMPROVEMENTS RELATING TO SUPPORTING PLATFORMS FOR NUCLEAR REACTORS. Hoskins, Leonard Maxwell; Derbyshire, Edward Carlos (to Fairey Engineering Ltd.). British Patent 1,086,054. Oct. 4, 1967. Filed May 13, 1963.

A design for a support platform for the driver region of the moderator of a zero-energy experimental reactor is given. A method for assembling the annular supporting bedplate is presented. (J.C.W.)

44958 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Stephens, John Esket (to Fairey Engineering Ltd.). British Patent 1,086,057. Oct. 4, 1967. Filed May 24, 1963.

The design and construction of a void tube in which a fuel sample can be oscillated at varying frequencies are given. The tube is removable in the central region of the reactor core. (J.C.W.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 43100, 43139, 43147, 43163, 43190, 43221, 43553, and 43580.

44959 (BMI-1813) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Progress Report for January–June 1967. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). Sept. 1, 1967. Contract W-7405-eng-92. 36p. Dep. CFSTI.

The rupture characteristics of defects in reactor coolant piping under boiling-water and pressurized-water conditions were investigated. Four full-scale tests were conducted on 24-in.-diameter, 1.50-in. nominal wall thickness A106B carbon steel pipe containing defects entirely through the wall thickness and surface defects partially through the thickness. The tests were conducted over a temperature range from 575 to 596°F under pressurized-water conditions and at nominal failure stress levels of 13,490 to 19,750 psi. Test results and piping material properties are tabulated and Charpy V-notch curves are presented for pipe specimens. (H.D.R.)

44960 (BNWL-CC-319) SPECIFICATION FOR NUCLEAR FAST REACTOR GRADE MIXED OXIDES (UO_2–PuO_2), COMPACTIBLE POWDER. Anderson, H. J. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 25, 1965. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

The physical and chemical characteristics and some process requirements of high density UO_2 particles enriched with PuO_2 (mixed oxides) to be used in the packed-particle nuclear fuel elements manufactured by the vibrational compaction process are presented. The high density particles are formed from nuclear grade UO_2 and PuO_2 powders that have been thoroughly blended by ball-milling, densified by a pneumatic impaction process, granulated and sieved, then recombined before fabrication. (auth)

44961 (ORNL-TM-1971) FABRICATION AND IRRADIATION TESTING OF SOL–GEL FUELS AT OAK RIDGE NATIONAL LABORATORY. Olsen, A. R.; Sease, J. D.; Fitts, R. B.; Lotts, A. L. (Oak Ridge National Lab., Tenn.). Sept. 1967. Contract W-7405-eng-26. 55p. (CONF-671008-1). Dep. CFSTI.

From Symposium on Sol–Gel Processes for the Production of Ceramic Nuclear Fuels, Turin, Italy.

Alternate procedures under development for fabricating oxide fuels from Sol-Gel process products are reviewed. Procedures include Vi-Pac, the high-energy vibratory compaction of angular particles; Sphere-Pac, the low-energy vibratory compaction of microspheres; powder preparation and pelletizing; extrusion of concentrated sols or clays; and pyrolytic C coating of microspheres. Also reported are compressive creep behavior of ThO_2 pellets, thermal conductivity of ThO_2 and THO_2–UO_2 pellets and Sphere-Pac ThO_2 beds, and irradiation performance of the various fuel forms. (auth)

44962 CLOSURE MEANS FOR A NUCLEAR REACTOR PRESSURE VESSEL STANDPIPE. Greaves, Thomas Cyril (to English Electric Co. Ltd.). British Patent 1,084,319. Sept. 20, 1967. Filed Nov. 1, 1963.

A design for a closure plug to close the end of a cylindrical standpipe penetrating a wall of a nuclear reactor vessel is presented. (J.C.W.)

44963 IMPROVEMENTS IN OR RELATING TO FUEL PENCILS HAVING A THIN FLEXIBLE CAN FOR NUCLEAR REACTORS. Alfeille, Lucien; Charrault, Jean-Claude; Lafontaine, Francois (to European Atomic Energy Community). British Patent 1,085,383. Sept. 27, 1967. Priority date Aug. 12, 1964, Belgium.

A fuel element for a nuclear reactor consists of a thin flexible can having longitudinal corrugations for radial deformation and helical corrugations for axial deformation. Stiffening wires are used in the longitudinal corrugations and are equidistant from one another. (J.C.W.)

44964 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT ASSEMBLIES FOR USE IN NUCLEAR REACTORS. Reimer, Stafford David Ian (to Babcock and Wilcox Ltd.). British Patent 1,085,182. Sept. 27, 1967. Filed July 23, 1965.

A design of a fuel element assembly is given. Each fuel element supports the adjoining element in a grid. (J.C.W.)

44965 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Hardy, Harold Kenyon; Walker, Vincent (to United Kingdom Atomic Energy Authority). British Patent 1,085,225. Sept. 27, 1967. Filed July 4, 1963.

A fuel element consists of a U bar enclosed in a can with helical heat transfer fins and longitudinal flow-splitter fins extending radially outward beyond the heat transfer fins. Helical guide vanes twisted in the opposite direction to the heat transfer fins are between each splitter fin. (J.C.W.)

44966 CLOSURE METHOD AND MEANS FOR THE ENDS OF NUCLEAR FUEL RODS HAVING A VERY THIN SHEATH. Alfille, Lucien; Bocquet, Jean-Pierre; Chaignon, Roger; Valentin, Georges (to European Atomic Energy Community). British Patent 1,085,382. Sept. 27, 1967. Priority date Feb. 13, 1964, Belgium.

Methods are given for using closure plugs having raised, upturned, or outwardly projecting rims or flanges. The thickness of the plug is the same as the fuel rod sheath to maintain uniform heat distribution during welding. (J.C.W.)

GENERAL

44967 (ANL–7309) MACRO-FORTRAN: A FACILITY FOR PROGRAMMER-DEFINED MACRO-INSTRUCTIONS IN FORTRAN PROGRAMS. Robinson, George A. (Argonne National Lab., Ill.). June 1967. Contract W-31-109-eng-38. 39p. Dep. CFSTI.

The language MACRO-FORTRAN, which enables the programmer to write specifications for generating sequences of FORTRAN statements and incorporate these sequences into his FORTRAN program in a natural fashion, is described. The MACRO-FORTRAN translator is written in 3600 FORTRAN. (W.H.K.)

44968 (BNL–50041) PROGRAMMED FINITE DIFFERENCE SOLUTION FOR ROTATING DISKS OF VARIABLE THICKNESSES. Reich, M. (Brookhaven National Lab., Upton, N. Y.). June 1965. 21p. Dep. CFSTI.

Finite difference stress solutions applicable to most shapes encountered in the design of rotating disks with no plane of symmetry are presented. The equations are then programmed for the 7094 computer by FORTRAN methods which are discussed in detail. Finally, the outlined methods are demonstrated in a step by step solution for the stresses inherent in a complex loaded rotating disk with no plane of symmetry. (auth)

44969 (BNWL-CC–591) HANFORD TEMPERATURE EFFECTS ON COLUMBIA RIVER FISHES. Nakatani, R. E.; Foster, R. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 5, 1966. Contract AT(45-1)-1830. 15p. Dep. CFSTI.

The present level of heat burden introduced by Hanford Operations into the Columbia River does not create any serious damage to the valuable salmon resources. However, the general warmer temperature regime of the Columbia River of recent years tends to favor the warm water fishes and should the temperatures of the lower Columbia River repeatedly reach or exceed 24°C during the peak season (August and September) those runs of salmon that migrate through the river at this particular season can be expected to decline. Portions of the summer and fall runs of chinook salmon are enroute to their spawning grounds during the critical period and now encounter water temperatures of about 21°C. These runs are especially vulnerable to further increases in river temperatures. The salmon runs that enter the river in the spring and late fall are far less vulnerable. (auth)

44970 (BNWL-SA–41) OXIDATION OF CARBON BY WATER VAPOR: CALCULATION OF REVERSE REACTION RATE FROM THE FORWARD RATE AND EQUILIBRIUM CONSTANT. Tingey, G. L.; Giberson, R. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 28, 1965. Contract AT(45-1)-1830. 7p. Dep. CFSTI.

Kinetics for the reverse reaction were calculated from data for the carbon-water vapor reaction and the equilibrium constant. Use of the principle of microscopic reversibility in determining the reverse rate is described and limitations of the method of Gadsby et al. are pointed out. (M.C.G.)

44971 (GEPP–7) THE MATHATRON DESKTOP COMPUTER/CALCULATOR. Buck, W. H. (General Electric Co., St. Petersburg, Fla. [Pinellas Peninsula Plant]). Sept. 1, 1967. Contract AT(29-1)-656. 36p. (R–67ND4). Dep. CFSTI.

A description of Mathatron logic is provided and basic rules required for programming are discussed. Several Mathatron programs, developed for statistical, quality control, and engineering use, are included in the appendix. When data are not excessive, it is more expedient to use the Mathatron than a computer using a remote terminal in time sharing applications. The Mathatron is easily operated by technicians and clerks, and it is extremely useful in engineering evaluation and statistical analysis work. (auth)

44972 (IS-T–195) PREPARATION AND INFRARED SPECTRA OF SOME POLYNUCLEAR TANTALUM HALIDE COMPOUNDS. Meyer, John Louis (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 49p. Dep. CFSTI.

Thesis.

The preparation and infrared characterization of several derivatives of the polynuclear tantalum halide ions $Ta_6X_{12}^{n+}$ where X = Cl, Br and n = 2, 3, 4 were studied. X-ray powder pattern data were obtained for some of the compounds and are presented with analytical data for these compounds. The compound $K_4[(Ta_6Cl_{12})Cl_6]$ was prepared by reacting stoichiometric amounts of KCl, $TaCl_5$ and Al in a sealed Vycor tube at 550°C for five days. The product was found to be contaminated with $KAlCl_4$ but gave an x-ray powder pattern almost identical to that of previously reported $K_4[(Nb_6Cl_{12})Cl_6]$. The hydrated compounds $Ta_6Cl_{12}Cl_3 \cdot 6H_2O$, $Ta_6Br_{12}Br_3 \cdot 6H_2O$ and $Ta_6Cl_{12}Br_3 \cdot nH_2O$ were prepared from aqueous solutions of $Ta_6Cl_{12}^{3+}$ or $Ta_6Br_{12}^{3+}$ by making the solution 0.1N in the appropriate hydrohalic acid and evaporating most of the solvent. The compounds $[(C_2H_5)_4N]_2[(Ta_6X_{12})X'_6]$ where X, X' = Cl, Br and $[(C_6H_5)_4As]_2$-$[(Ta_6Cl_{12})Cl_6]$ were prepared from solutions of $Ta_6X_{12}^{2+}$ in methanol or ethanol by saturating the solution with the appropriate anhydrous hydrohalic acid, adding an excess of tetraethylammonium halide or tetraphenylarsonium chloride, and evaporating most of the solvent. A similar compound $[(C_2H_5)_4N]_3[(Ta_6Cl_{12})Cl_6]$, was prepared analogously starting with an ethanolic solution of $Ta_6Cl_{12}^{3+}$ and carrying out the preparation in an oxygen-free atmosphere. Far-infrared spectra of all the compounds prepared except $[(C_6H_5)As]_2[(Ta_6Cl_{12})$-$Cl_6]$ were obtained over the region from 600 to 50 cm^{-1} and are presented graphically. The absorption bands and their tentative assignments are tabulated. (auth)

44973 (LA–3720) FORTRAN SIN: A ONE-DIMENSIONAL HYDRODYNAMIC CODE FOR PROBLEMS WHICH INCLUDE CHEMICAL REACTIONS, ELASTIC-PLASTIC FLOW, SPALLING, AND PHASE TRANSITIONS. Mader, Charles L.; Gage, William R. (Los Alamos Scientific Lab., N. Mex.). May 20, 1967. Contract W-7405-eng-36. 64p. Dep. CFSTI.

A CDC 6600 computer FORTRAN code for computing one-dimensional hydrodynamic problems in slab, cylindrical, or spherical geometry using realistic equations of state is described. Features available in the code include chemical reaction using an Arrhenius rate law, the C–J volume burn, or, for slabs, a gamma-law Taylor wave; elastic–plastic flow using the Hooke's law–Von Mises yield model; and spalling using the Whiteman and Skidmore model of the tensile stress at spalling as a linear function of the square root of the stress rate. The HOM equation of state is used to compute the equation of state for detonation products, undecomposed explosives, mixtures of the two, and condensed components which may have an instantaneous phase change. (auth)

44974 (ORNL-TM-1933) "MATEXP," A GENERAL PURPOSE DIGITAL COMPUTER PROGRAM FOR SOLVING ORDINARY DIFFERENTIAL EQUATIONS BY THE MATRIX EXPONENTIAL METHOD. Ball, S. J.; Adams, R. K. (Oak Ridge National Lab., Tenn.). Aug. 30, 1967. Contract W-7405-eng-26. 60p. Dep. CFSTI.

MATEXP, a general purpose digital computer program which was written for solving systems of ordinary differential equations by the matrix exponential method is discussed. MATEXP has several advantages over standard numerical integration routines. It gives virtually exact solutions of constant-coefficient homogeneous equations and to nonhomogeneous equations for which the forcing functions are constant during the computation interval. The speed at which the equations are solved and the accuracy of the solution are essentially unaffected either by the degree of cross-coupling of the equations or by whether or not the coefficient matrix is nonsingular or that its eigenvalues are distinct. (auth)

44975 (ORNL-TM–1951) OSCILLATOR STRENGTHS IN MAGNESIUM PORPHIN. Johnson, L. D.; Schweinler, H. C. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 129p. Dep. CFSTI.

Thesis. Submitted by L. D. Johnson to Univ. of Tennessee, Knoxville.

Molecular orbitals were written as linear combinations of atomic orbitals for magnesium porphin, a chlorophyll prototype. Oscillator strengths for the allowed electronic transitions were calculated. An atomic orbital basis set of orthonormalized, real Slater orbitals was used. All electrons outside closed atomic shells were considered. Magnesium porphin has D_{4h} symmetry. Symmetry orbitals were obtained by applying group theoretical projection operators to the atomic orbitals. The symmetry orbitals were orthonormalized by diagonalizing their overlap matrix. The Hartree–Fock molecular orbitals were formally written as linear combinations of the set of orthonormalized symmetry orbitals. The resulting eigenvalue equation was separated into two parts using the property that each of the atomic orbitals is an approximate solution to an atomic Hartree–Fock equation, and an approximate solution was obtained by perturbation methods. The result was a set of molecular orbitals that were energy weighted according to the atomic orbitals involved. Oscillator strengths for every electronic transition allowed by symmetry were calculated using this set of molecular orbitals. The results indicated that all major electronic transitions occur under the influence of light polarized in the plane of the molecule. The Soret band is attributed to transitions involving orbitals belonging to the two di-

mensional irreducible representation whose simple polynomial basis function is x^2-y^2. (This polynomial has nodal surfaces at the nitrogen positions.) A strong absorption band in the region of 3,200 A is predicted. (auth)

44976 (ORNL-TM-1952) DIFFERENTIABILITY OF SET FUNCTIONS. Wright, H. A.; Snyder, W. S. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 61p. Dep. CFSTI.

Thesis. Submitted by H. A. Wright to Univ. of Tennessee, Knoxville.

Various properties of the upper and lower (F,α) derivates and of the (F,α) derivative of an arbitrary real and finite-valued function defined on the sets of a family F of measurable subsets of Euclidean n-space R_n, where α is a real number such that $0 < \alpha < 1$, are evaluated. Properties discussed include measurability, finiteness, boundedness, existence of the derivative, and summability. A discussion of the historical background of the subject and definitions and basic concepts is included. (W.H.K.)

44977 (ORNL-TM-1969) THE EFFECT ON PROGRAM EXECUTION TIME OF THE USE OF FORTRAN MULTISUBSCRIPTED VARIABLES. Sullivan, J. G. (Oak Ridge National Lab., Tenn.). Sept. 5, 1967. Contract W-7405-eng-26. 31p. Dep. CFSTI.

The computer time needed to execute a program written in FORTRAN can be improved considerably if the programmer understands the implications of the use of multidimensioned variables. Basic information so that a programmer may be able to produce programs which are efficient in their use of computer time is presented. (auth)

44978 (ORNL-TM-1998) BRANCHING IN FORTRAN. Sullivan, J. G. (Oak Ridge National Lab., Tenn.). Sept. 25, 1967. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The execution time of FORTRAN programs can be improved by properly considering both the method used to cause a program branch and the position of the branch point. The discussion points out some general rules which can be applied to FORTRAN programs which will improve execution time. (auth)

44979 (ORO-3108-30) THEORY OF ELECTRON DIFFRACTION IN CRYSTALS WITH PARTICULAR APPLICATION TO THE CONTRAST OF VOIDS. Ingram, John Charles (Virginia Univ., Charlottesville). Aug. 1967. Contract AT(40-1)-3108. 74p. Dep. CFSTI.

Thesis.

Theoretical intensity profiles of spherical voids in Al and Au were calculated using Howie–Whelan equations in conjunction with the theoretical displacement field of a void. Good agreement was found between theoretical and experimental images in many cases, even when such seemingly strong approximations as the two-beam approximation, the column approximation, and the distorted internal potential were used. (P.C.S.)

44980 (RFP-965) EVALUATION OF THE OPTOMECHANISMS LASER INTERFEROMETER SYSTEM. Utley, L. W. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Sept. 7, 1967. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

A laser length-measuring interferometer system purchased from OPTOmechanisms, Inc., is evaluated. The system is used to calibrate the longitudinal lead screw of a No. 4 Moore Products Company Measuring Machine and to calibrate the linearity adjustment of a Sheffield Corporation Measuring Machine. Both performances prove the interferometer system to be extremely accurate. (auth)

44981 (RISO-M-588) TIME-DELAY SIMULATED ON PDP-8 AND EAI-680. Poulsen, N. J. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 15p. (R-11-67). Dep.

A program is described which is used for computer simulation of a time-delay in such a way that a varying or fixed voltage is read into the PDP-8 digital computer via one analog input channel and reproduced after previously determined times on analog output channels. (auth)

44982 (RISO-M-589) OFF-LINE DATA INPUT-OUTPUT PROGRAMS FOR PDP-8. Christensen, P. la Cour (Danish Atomic Energy Commission, Risoe. Research Establishment). July 1967. 20p. (R-12-67). Dep.

The programs can be used for off-line check and correction of data in floating form, or as single word or double word integers. Communication with the memory is via the Teletype machine. (auth)

44983 (SC-CR-67-2726) FPPP: AN SDS 930 PROGRAM FOR QUICK-LOOK PLOTS. Unkrich, L. B. (Dikewood Corp., Albuquerque, N. Mex.). Aug. 31, 1967. Contract AT(29-1)-789. 25p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The First Pass Plot Program, which is an SDS 930 program for quick-look plots, is described. Subroutines, input, output, operation, flow chart, and main program listing are included. (W.H.K.)

44984 (SC-DC-66-1577) EXPLOSIVE PUMPING OF LASERS. [Anderholm, N. C.] (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 12p. (CONF-670821-1). Dep. CFSTI.

From Meeting of the American Physical Society, Seattle, Wash.

The design and performance of a ruby laser using shocked argon gas as a pump source is presented. The output occurs about 50 μsec after the argon is shocked and continues until the shock destroys the ruby. The energy output is of the order of a few joules. (auth)

44985 (SC-DC-67-2065) A STUDY OF HEPA FILTER EFFICIENCY IN SUBMICRON PARTICLE RANGE. Tillery, M. I. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.); Klamerus, L. J. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 14p. (CONF-670919-3). DTIE.

From AEC/NSA Contamination Control Symposium, Albuquerque, N. Mex.

Techniques used to evaluate the efficiency of HEPA filters on particles less than 0.5 microns in size are described. A brief discussion is given of a gas sampling procedure used in a laminar-flow clean room. Efficiency figures are given for HEPA filters on particles less than 0.3 micron in size as generated in a Uranine aerosol. (auth)

44986 (SC-DC-67-2103) SELF-CONTAINED FIRE EXTINGUISHING SYSTEM FOR MOBILE ELECTRONIC FACILITIES. Duke, Vernon L.; Glover, N. Richard (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 7p. (CONF-670936-1). Dep. CFSTI.

From AEC Industrial Safety Meeting, Chicago, Ill.

The need and design of a fire extinguishing system for mobile electronic units is presented. The detection system, alarm and evacuation time-delay system, hold or lockout system, suppressant releasing system, suppressant storage and distribution system, and power shutdown system are discussed. (W.H.K.)

44987 (SC-R-67-1097) ENVIRONMENTAL ENGINEERING ABSTRACTS. (Sandia Corp., Albuquerque, N. Mex.). May 15, 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

A bibliography is presented which contains references to published literature on environmental engineering. (F.S.)

44988 (SC-RR-67-489) TABLES OF FACTOR CORRELOGRAMS OF ORDERS TWO THROUGH SIX. Simmons, G. J. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 126p. Dep. CFSTI.

The two-sided correlation function, X * Y (correlogram), is tabulated for code lengths of two through six symbols. Since the principal use of these tables will be for the construction of lengthy binary sequences with specified correlation properties, the analytical methods required for this application are also developed. The correlograms were computed on the CDC 3600 using the product rule and the accuracy of the printed tables was verified by a column sum technique. It was decided to terminate the tables with the 6×6 correlograms, in spite of the desirability of having codes with the prime length seven available as factors for code construction, since the number of entries for the n-th order folded table is $N = \Sigma_{i=2}^{n} 2^i (2^{i-1} - 1)$ which would have required 300 additional pages for the inclusion of seven symbol codes. (auth)

44989 (SC-RR-67-656) ROLAMITE: A NEW MECHANICAL DESIGN CONCEPT. Wilkes, D. F. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 223p. Dep. CFSTI.

The rolamite geometry, recently developed by Sandia Laboratory, forms an extremely tolerant precision rolling suspension suitable for a wide range of applications and does not require precision tolerance machining to manufacture. Rolamite exhibits coefficients of friction 1 to 10 percent of the values obtained from conventional bearings; no lubrication is required. Rolamite geometry produces axial forces of any desired character. It can provide nearly all the mechanical functions normally discussed in mechanical engineering machine design textbooks as well as many electromechanical functions. The simplicity of the rolamite geometry enables the design of innumerable complete electromechanical devices composed of only 4 to 10 piece-parts. A modular design is being developed suitable for producing

a wide range of microminiature weapon components in which one key part provides from 80 to 95 percent of the necessary functions. These parts, to be designed by a computerized process, will be produced by strip-processing by means of high-rate photochemical methods and photo masters which could easily be adapted for mass production. These masters are traced out automatically from machine tool instructions produced during the original computer design process. (auth)

44990 (SC-TM-67-593) VACUUM ULTRAVIOLET SPECTROMETER FOR CARIBOO II. Herrington, P. B. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 37p. Dep. CFSTI.

The ultraviolet spectrometer designed for Cariboo II for studying physical phenomena which occur in the upper atmosphere during an aurora is described. A detailed discussion of the design and development of the electronic system and techniques for calibrating the optical system of the spectrometer is presented. (auth)

44991 (SC-TM-67-712) PNEUMATICALLY EXCITED TUNING FORK. Sidell, R. S. (Sandia Corp., Albuquerque, N. Mex.). Sept. 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

If a tuning fork is combined with a flapper nozzle valve, the plenum pressure in the flapper nozzle valve will fluctuate at a frequency near the undriven tuning fork frequency. The system is dynamically unstable, and the oscillation will persist. The system was analyzed and the effect of parameter variations determined. It is found that large variations in the pneumatic parameters have a negligible effect on the frequency. (auth)

44992 (SCL-DR-67-75) RELIABLE PARALLEL-GAP SOLDERING FOR SILICON INTEGRATED CIRCUIT FLAT PACKS. Noble, R. P. (Sandia Corp., Livermore, Calif.). Sept. 1967. Contract AT(29-1)-789. 72p. Dep. CFSTI.

The fabrication parameters associated with high quality, parallel-gap soldered connections are reported. A statistical analysis of test data demonstrates that high strength, parallel-gap soldered connections are practical to produce. Nondestructive and destructive test methods are discussed, and, a bibliography of related publications is included. (auth)

44993 (SCL-DR-67-100) DETERMINATION OF PHASE FROM THE AMPLITUDE OF A MINIMUM-PHASE SYSTEM. Humphrey, R. E. (Sandia Corp., Livermore, Calif.). Sept. 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

A method for determining the phase angle of a minimum phase-shift transfer function at a given frequency from the magnitude as a function of frequency is described. The computational algorithm used depends on the assumption that the logarithm of the amplitude as a function of the logarithm of frequency can be approximated by a piecewise linear, continuous function. A computer program written in FORTRAN is included. (auth)

44994 (TID-3742) BIBLIOGRAPHIES OF ATOMIC ENERGY LITERATURE. Issued or in Progress During the Period, July-August 1967. (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). 12p. DTIE Free.

Ninety-seven bibliographies of atomic energy literature which have been issued or are in preparation are listed. A report number index is also included. (B.G.D.)

44995 (UCID-15199) LASER TRIGGERED SPARK GAP. Steinmetz, Lloyd L. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 15, 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

A laser triggered spark gap (LTSG) was developed to supply an output pulse synchronized with the laser output. The LTSG output voltage can be varied up to about 10 kV. The triggering threshold is discussed and is a strong function of focused spot size, which in turn depends on the focusing lens and the spatial energy distribution in the laser output. Some of the prominent features of the LTSG can be listed, but the qualifications and conditions discussed later should be used in the interpretation of these numbers: threshold power, <60 kW; threshold energy, <200 micro joules; jitter, not measurable; delay, not measurable; output pulse width, determined by circuit components; and output rise time, <3 ns (10-90%). (auth)

44996 (UCID-15202) THE INFRARED DETERMINATION OF POLY(2,2-DINITROPROPYL ACRYLATE) IN LX-09. Selig, Walter (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 28, 1967. Contract W-7405-eng-48. 5p. Dep. CFSTI.

An infrared method for the determination of poly(2,2-dinitropropyl acrylate) in the explosive LX-09 is presented. The procedure is based on the absorption of the carbonyl group near 1750 cm^{-1} in dimethylsulfoxide solution. Only a single standard is required for construction of a calibration curve. (auth)

44997 (UCRL-17594) EFFECT OF PERIODIC MENISCUS DISPLACEMENTS ON THE PERFORMANCE OF POROUS GAS ELECTRODES. Roussillon, Jean-Pierre (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 97p. Dep. CFSTI.

Thesis.

The influence of periodic movement of the gas–electrolyte interface in a film-type porous gas electrode was studied experimentally for the oxygen cathode in 2N KOH electrolyte. A single silver capillary tube of 150-μ ID was used as a cathode. The interface motion was obtained by displacement of the electrolyte in a closed compartment by a small piston driven mechanically at controlled frequency and amplitude. Measurements of the response of the cathode potential relative to the mercury/mercuric oxide reference electrode were made under galvanostatic conditions. The results obtained could not be quantitatively interpreted because of the deviation of conditions in the capillary electrode from design conditions. These included the resistance of extraneous ionic current paths and variations in local electrode kinetic behavior along the pore wall. Nevertheless, qualitative effects of the meniscus movement were observed; they were characterized by a periodic response of the cathode potential of a few millivolts amplitude. These effects indicated a decrease in overpotential during the advance of the meniscus toward the gas filled portion of the capillary, and an increase during motion in the opposite direction, as might be expected on the basis of film electrode models. (auth)

44998 (UCRL-17659) APPROXIMATE DIFFERENTIATION BY CUBIC SPLINE FITTING. Young, Jonathan D. (California Univ., Berkeley. Lawrence Radiation Lab.). June 12, 1967. Contract W-7405-eng-48. 9p. Dep. CFSTI.

Cubic spline fitting of a discrete function, $\{x_i, y_i\}$ with a new technique for terminal derivatives for estimating first derivatives at the points x_i is discussed. SPLYND, a CHIPPEWA FORTRAN subroutine for the CDC 6600, which will perform the computation, is described. (auth)

44999 (UCRL-17742) NUMERICAL APPLICATIONS OF CUBIC SPLINE FUNCTIONS. Young, Jonathan D. (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 4p. Dep. CFSTI.

The application of cubic spline fitting to estimation of second derivatives for interpolation, and integration of a function y(x) known only in discrete form as a table (x_i, y_i), i = 1, I is discussed. (auth)

45000 (UCRL-17758) TREATISE IN ORGANIC GEOCHEMISTRY. McCarthy, Eugene Desmond (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 1967. Contract W-7405-eng-48. 290p. Dep. CFSTI.

Thesis.

Major problems in organic geochemistry and how they relate to the more fundamental scientific questions of chemical evolution and the origin of life were studied. Almost all the analytical techniques of modern organic chemistry were utilized in the structural identification of organic components isolated from a series of crude oils and sediments. Since the major part of the work concentrated on the hydrocarbons, there was a particular emphasis on capillary gas chromatography and mass spectrometry. The isoprenoid hydrocarbons, generally considered to be derived from the biological precursor phytol, were extensively studied in a series of geological samples of different ages. In general, the acyclic saturated isoprenoid hydrocarbons were not found in recent sediments where degradation processes do not seem to have taken place to any detectable degree. The C_{17} isoprenoid, 2, 6, 10-trimethyltetradecane, was isolated and identified from Antrim Shale. Its structure was confirmed by capillary gas chromatography coinjection techniques. In keeping with the diagenetic scheme postulated, in which the C_{17} isoprenoid is considered to derive from a C_{20} isoprenoid by a two-carbon cleavage, this isoprenoid hydrocarbon is found in significantly smaller amounts than the other isoprenoid hydrocarbons. Two C_{19} isoprenoid hydrocarbons, isomeric with pristane, were synthesized and the mass spectra of the three isomers compared. The close similarity of the mass spectra emphasizes the danger of identifying individual components from a hydrocarbon mixture on the basis of mass spectrometry alone. Adopting a similar approach, the C_{21} isoprenoid hydrocarbon, which was isolated from several geological samples, was assigned the structure 2,6,10,14-tetramethylheptadecane, and it was considered to derive from a C_{40} compound, such as lycopene, or from some higher homologue. Diagenetic pathways are discussed in detail. Serious consideration is given to the fundamental premise on which the organic geochemical approach rests, that isoprenoid compounds are necessarily indicative of biological origin. The idea that isoprenoid compounds could arise by nonbiogenic pro-

cesses was from both the thermodynamic standpoint and the biosynthetic standpoint. Although the overwhelming proportion of the evidence still indicates a biogenic origin for the organic components from crude oils and certain shales, ambiguities do arise when the identity of the hydrocarbon material is less clearly understood. An attempt was made to establish criteria that will distinguish between those hydrocarbons derived from biological sources and those derived from nonbiogenic sources. It was concluded that the acyclic isoprenoid structure by itself cannot be regarded as an unequivocal marker of biological origin. (M.C.G.)

45001 (Y-1589) SPARK-GAP TOOL-SETTING SYSTEM. Asmanes, C. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 20, 1967. Contract W-7405-eng-26. 17p. Dep. CFSTI.

An automatic tool-setting system has proven satisfactory for most machine tools requiring a high degree of accuracy in establishing tool position. The system utilizes a spark, between a probe or tool-setting station and the cutting edge of the tool, to establish a point as a repeatable gap for tool positioning. The system permits the machining of parts to very close tolerances on a production basis. (auth)

45002 (Y-DM-5) INDEX OF ASTME TECHNICAL PAPERS ON MACHINING AND DIMENSIONAL MEASUREMENT. Broders, M. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). July 14, 1967. Contract W-7405-eng-26. 68p. Dep. CFSTI.

A "KWIC-Permuted Title Index" has been prepared for selected technical papers published since January 1960, by the American Society of Tool and Manufacturing Engineers (ASTME) on the subjects of MACHINING and DIMENSIONAL MEASUREMENT. The index consists of three major sections: a permuted title subject index, a personal author index, and a bibliographic section. The bibliographic section is arranged chronologically according to year of publication and includes a title, personal author, and ASTME paper number for each technical paper referenced. (auth)

45003 (RFP-Trans-28) SIEMENS MEASUREMENT TECHNOLOGY. MAINTENANCE OF THE KRISTALLOFLEX 4. Instruction Manual 431 W1. (Siemens und Halske A. G., Karlsruhe (West Germany)). Translated for Dow Chemical Co., Rocky Flats Div., Golden, Colo., from a manual. 37p. Dep. CFSTI. JCL $3,60 fs, $1,31 mf.

A maintenance manual for the Siemens and Halske Kristalloflex 4 x-ray equipment is presented. Circuit diagrams and error detection keys for apparatus with fabrication numbers from U13 -186 to -265 are included. (W.H.K.)

45004 MULTIBULB VISCOMETER (Engineering Drawings). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE-1644). 7 drawings.

A three-bulb glass viscometer for semiautomatically determining the efflux times of a liquid at three different consecutive shear rates is described. Data are obtained by measuring the time required for the sample level to fall between a pair of meniscus detectors located above and below each bulb along a vertical tube. The meniscus detector assemblies utilize a common exciter lamp, flexible fiber-optics light pipes to transmit the optical signals, and photoconductive cell bridges. Solid state amplifiers are employed to actuate precision timers which store the efflux time data until reset. The timer storage capacity is 1000 seconds in 0.1 second increments, and a readout resolution of ±0.02 seconds can be attained by interpolation. A maximum overall error (95% C.I.) of 0.14 second was obtained using a distilled water sample in a stirred but not temperature-controlled water bath. The sample requirement for the instrument is 4.5 to 5.5 ml. (For details see TID-4100 Suppl. 42) (auth)